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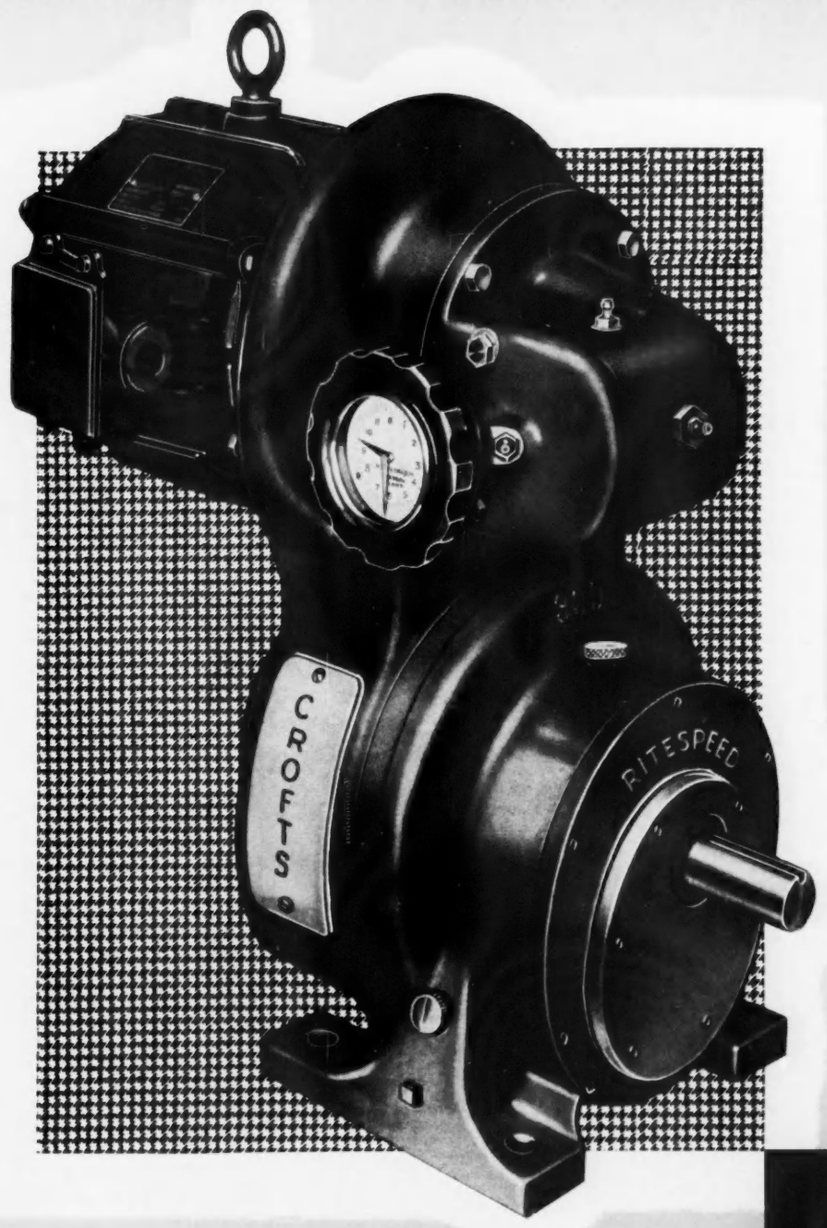

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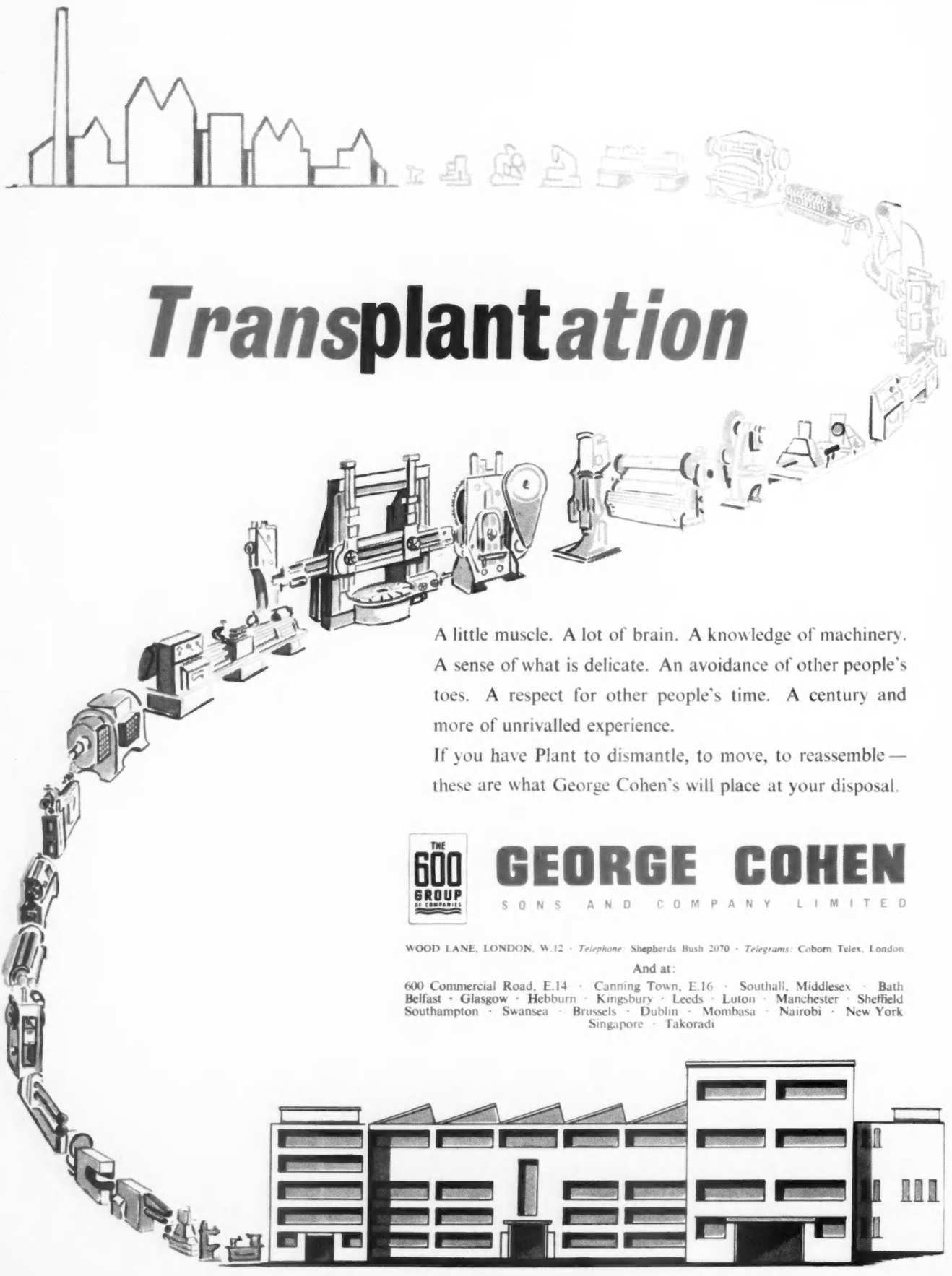

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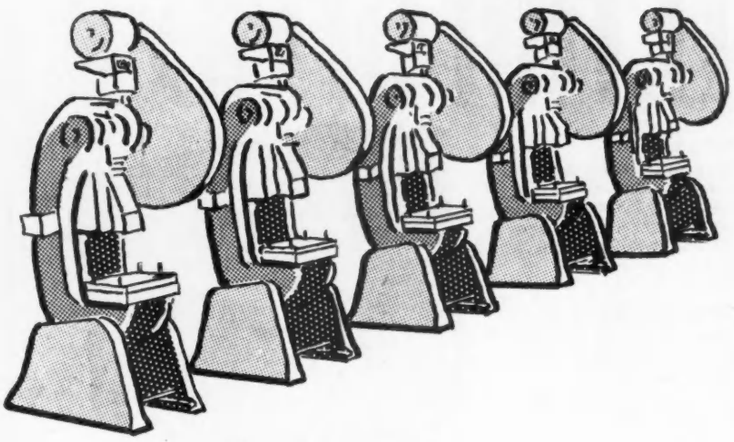

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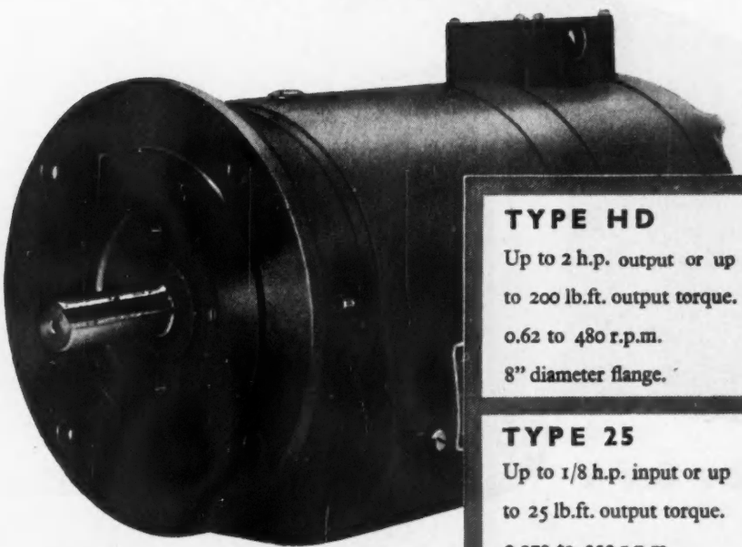

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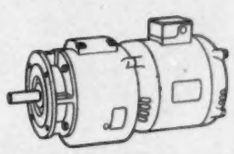

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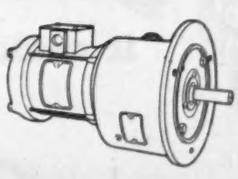

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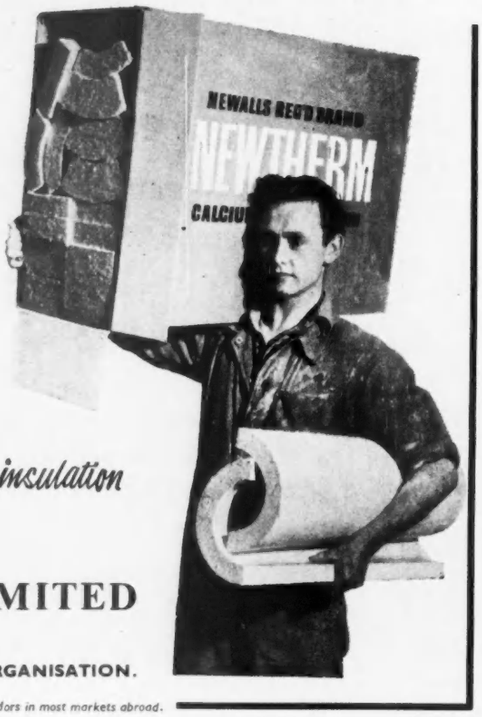

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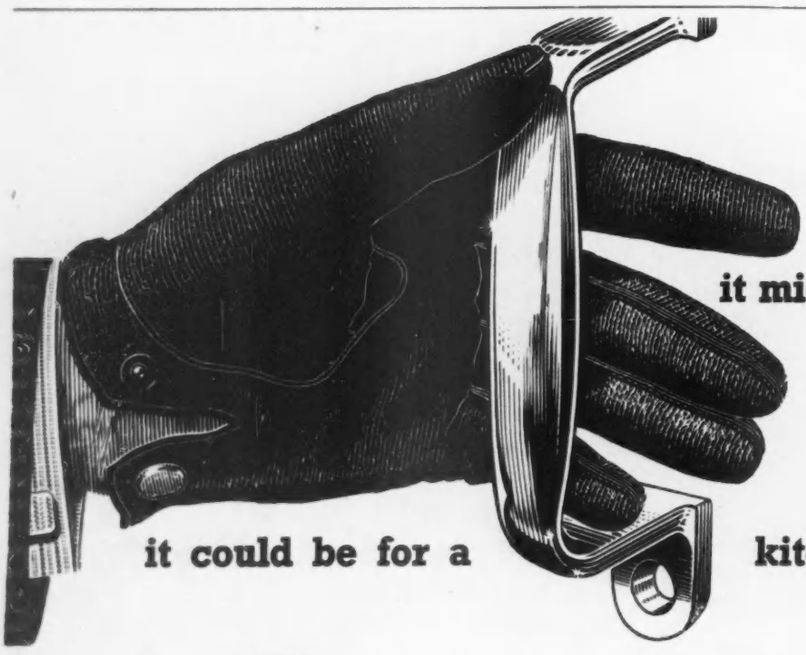

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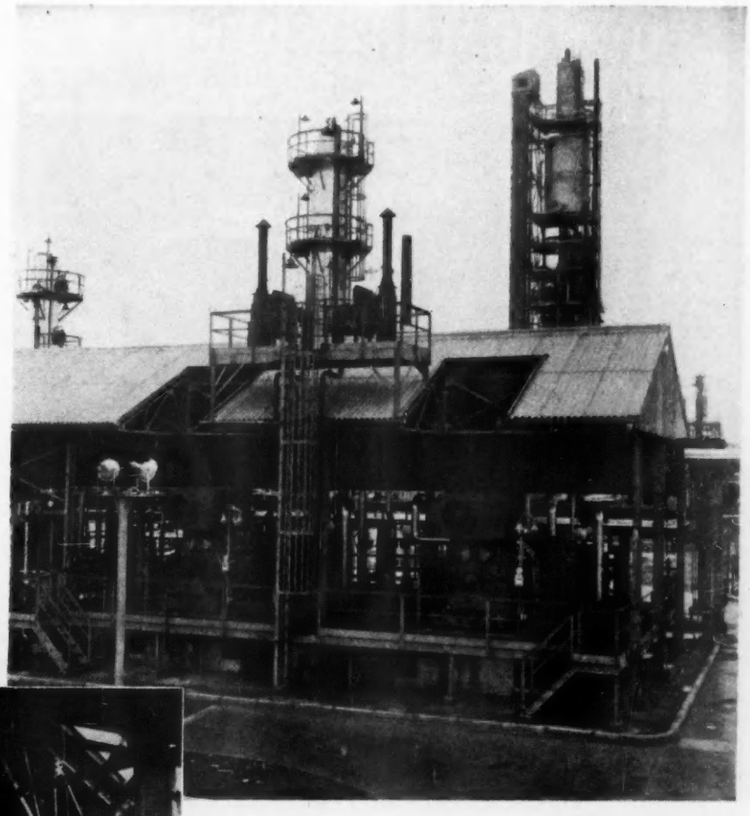

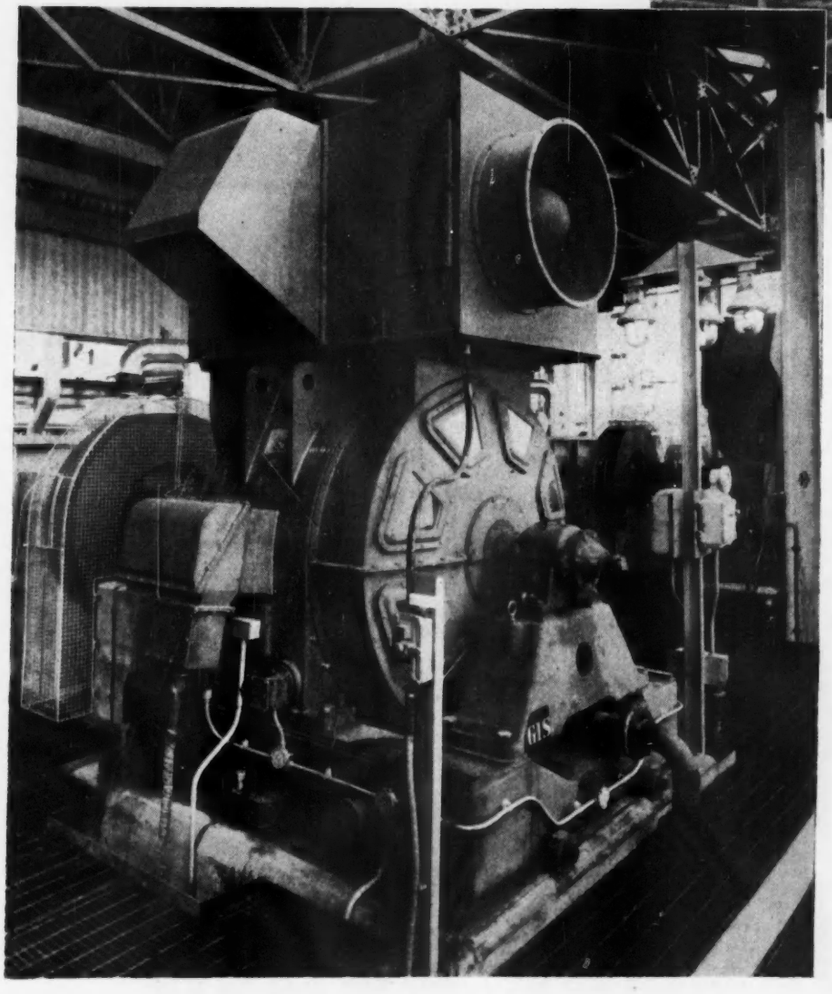

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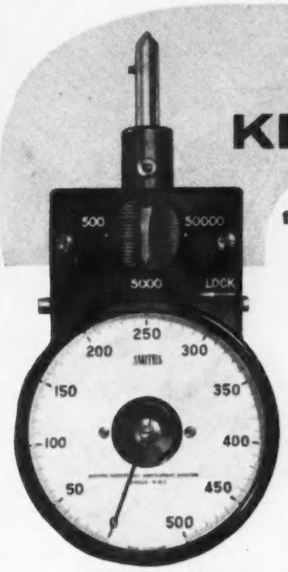

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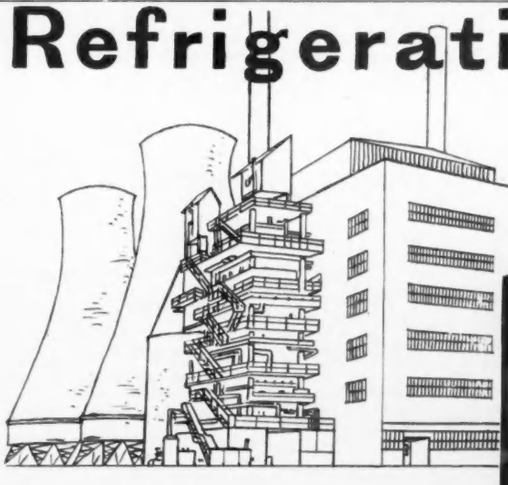

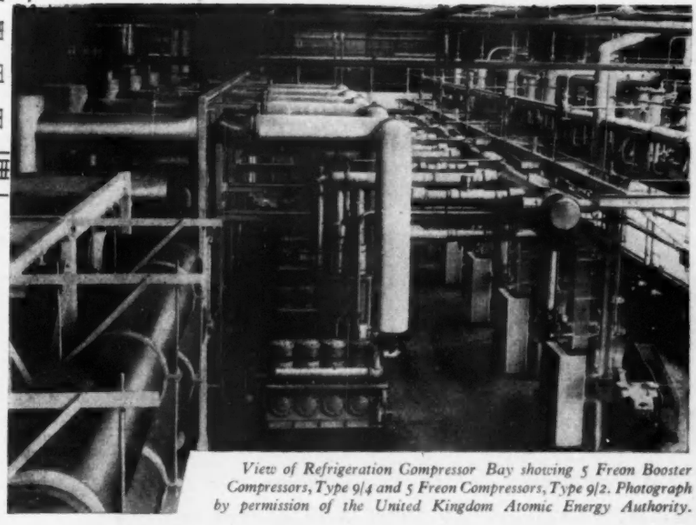

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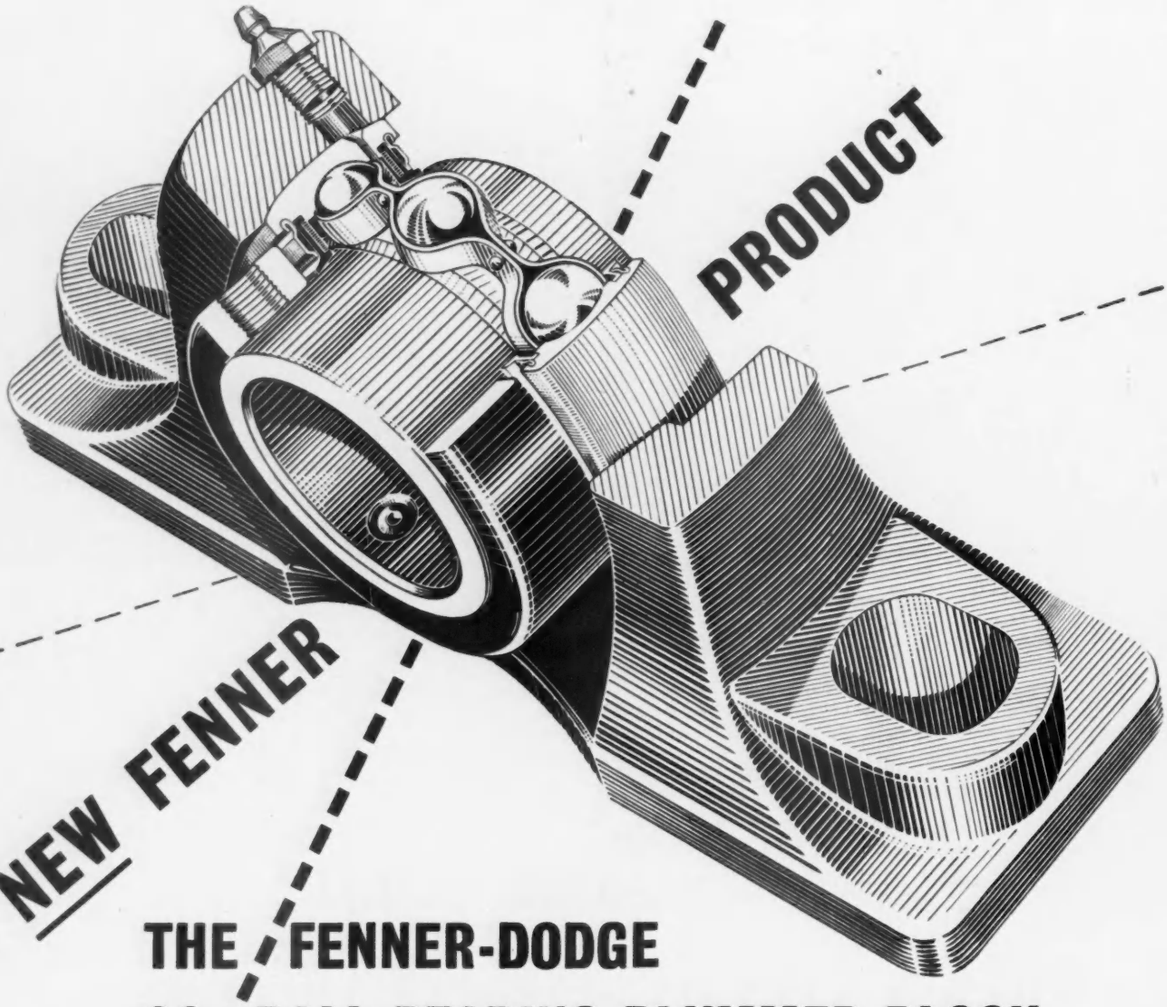

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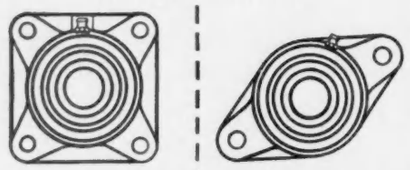

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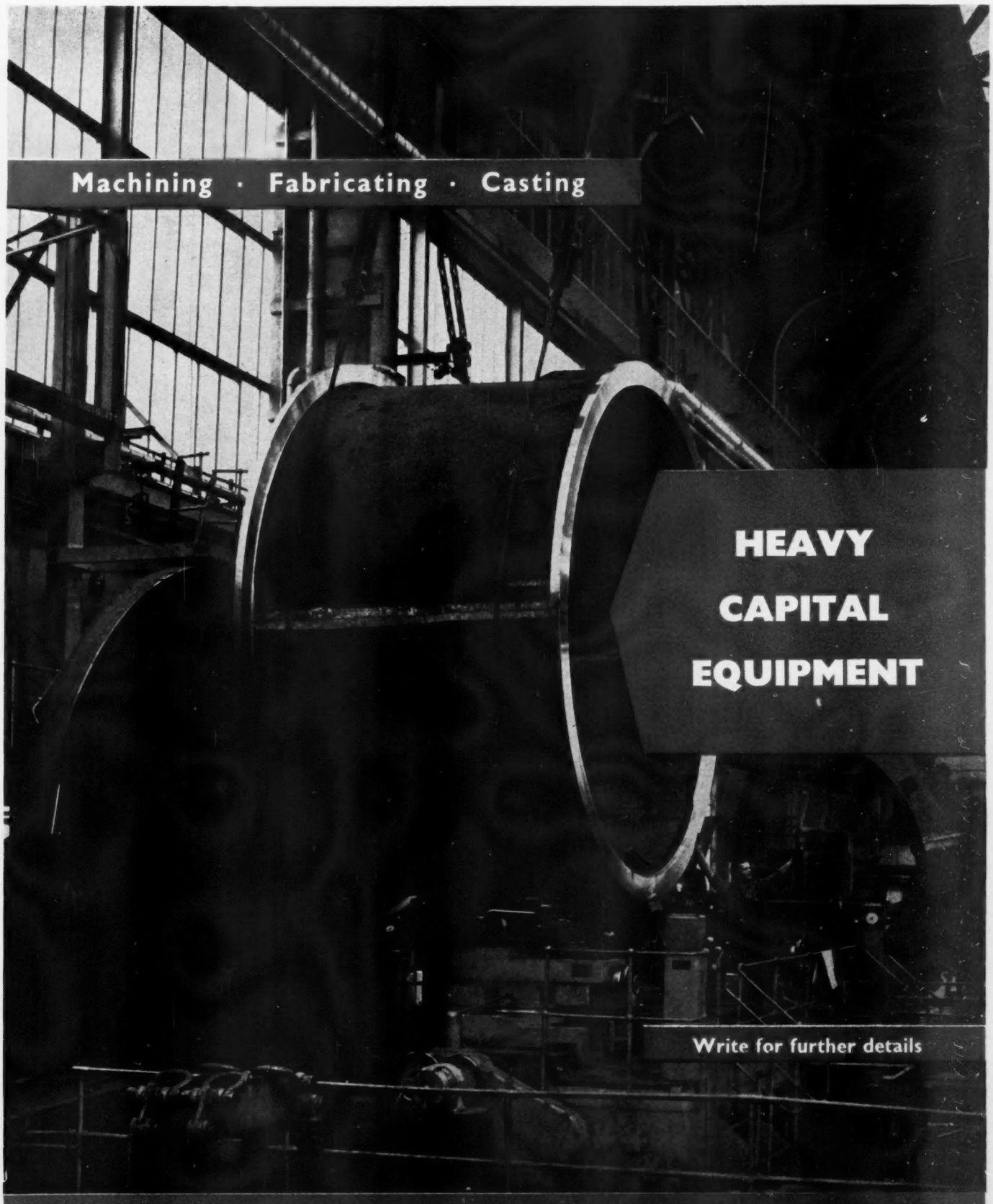

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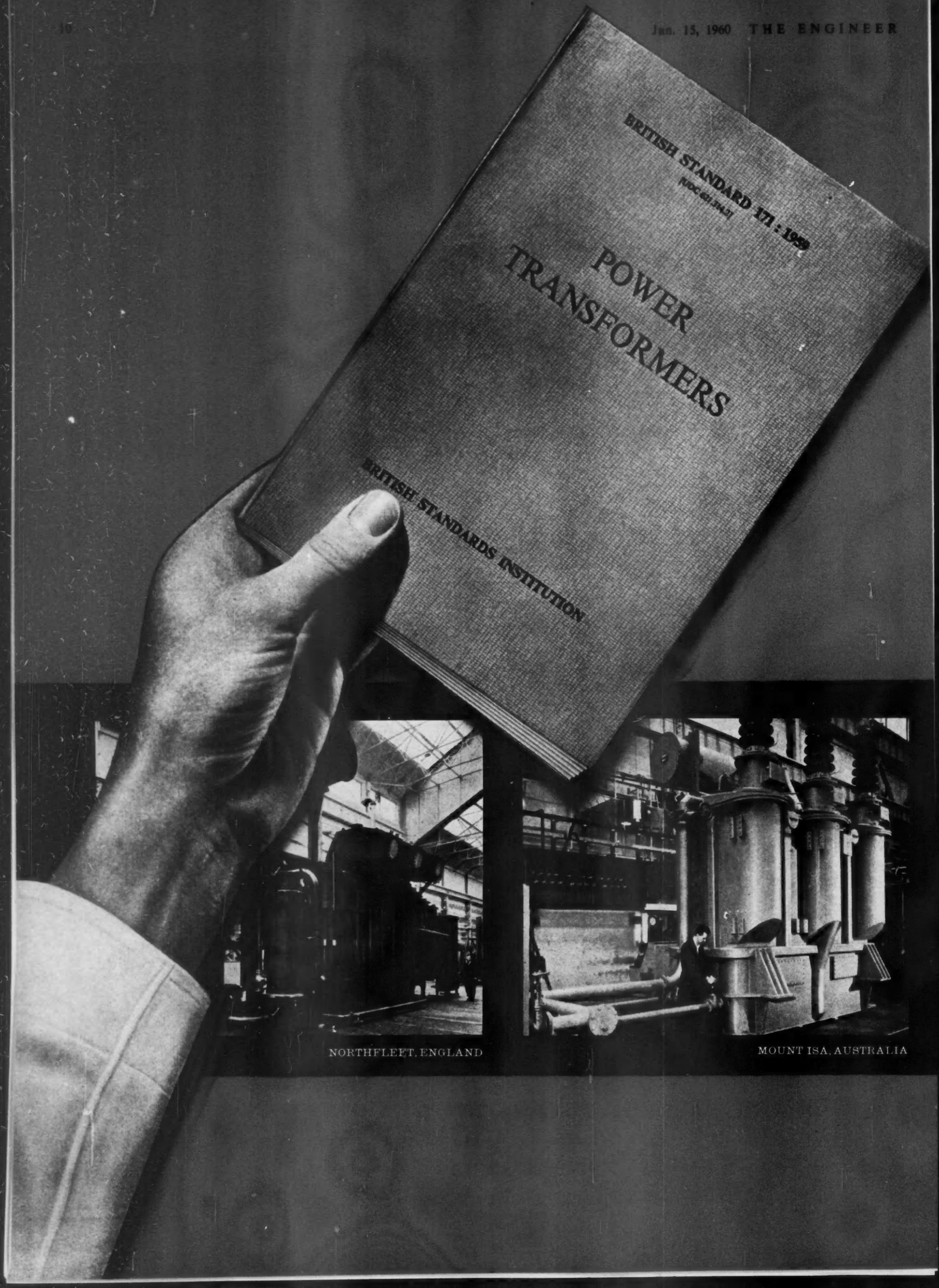
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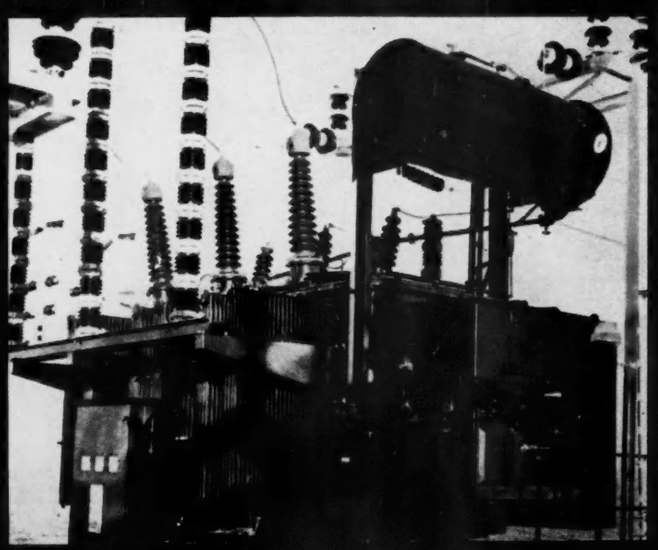

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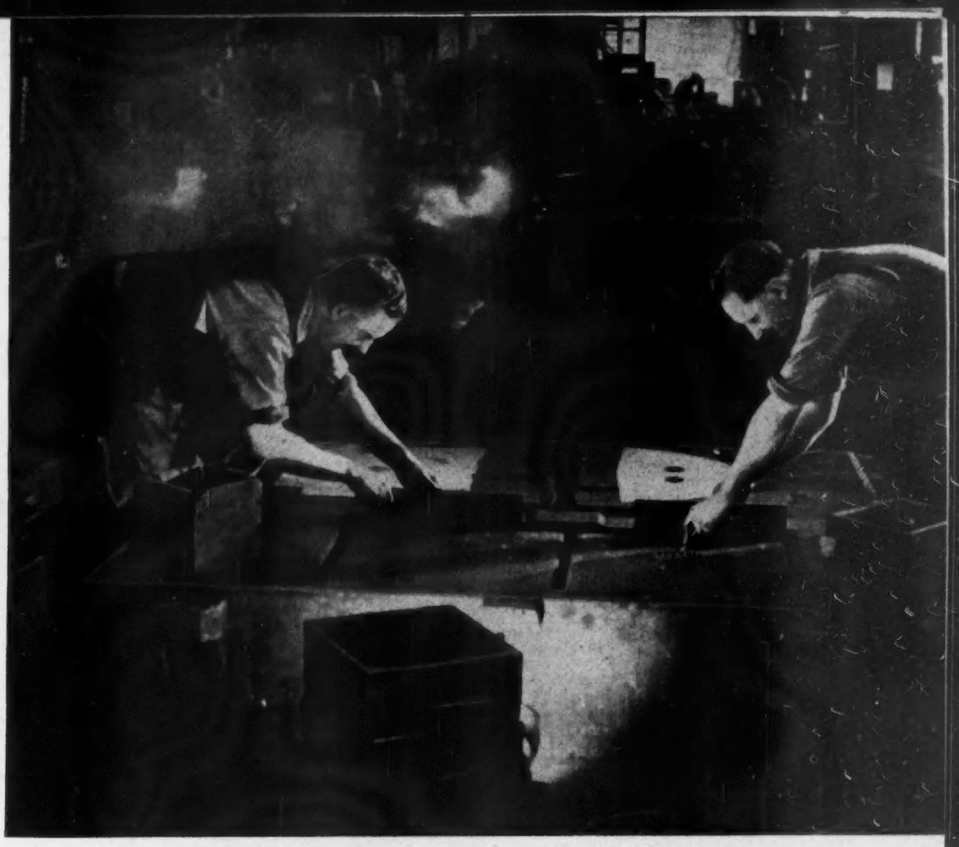

NEWTON CHAMBERS now cast in MEEHANITE

Our large modern foundries at Thorncliffe can now produce all classes and sizes of castings in the various types of Meehanite metal. This important addition to our already very extensive foundry facilities enables us to offer an exceptionally skilled and comprehensive casting service. Our long experience of serving almost every major industry gives us a unique understanding of special needs and problems.

Whether you require one casting or thousands, we can meet your needs promptly, in sizes from a few pounds up to 20 tons in weight. Production methods include light, medium and heavy machine moulding, as well as floor, loam and shell moulding. A skilled patternmaking service is at your disposal. Your machining and fitting requirements can be undertaken by our fully modernised machine shops.

All enquiries will receive immediate attention

Newton Chambers

ENGINEERING DIVISION · THORNCLIFFE · SHEFFIELD

ENGINEERS OF PROGRESS

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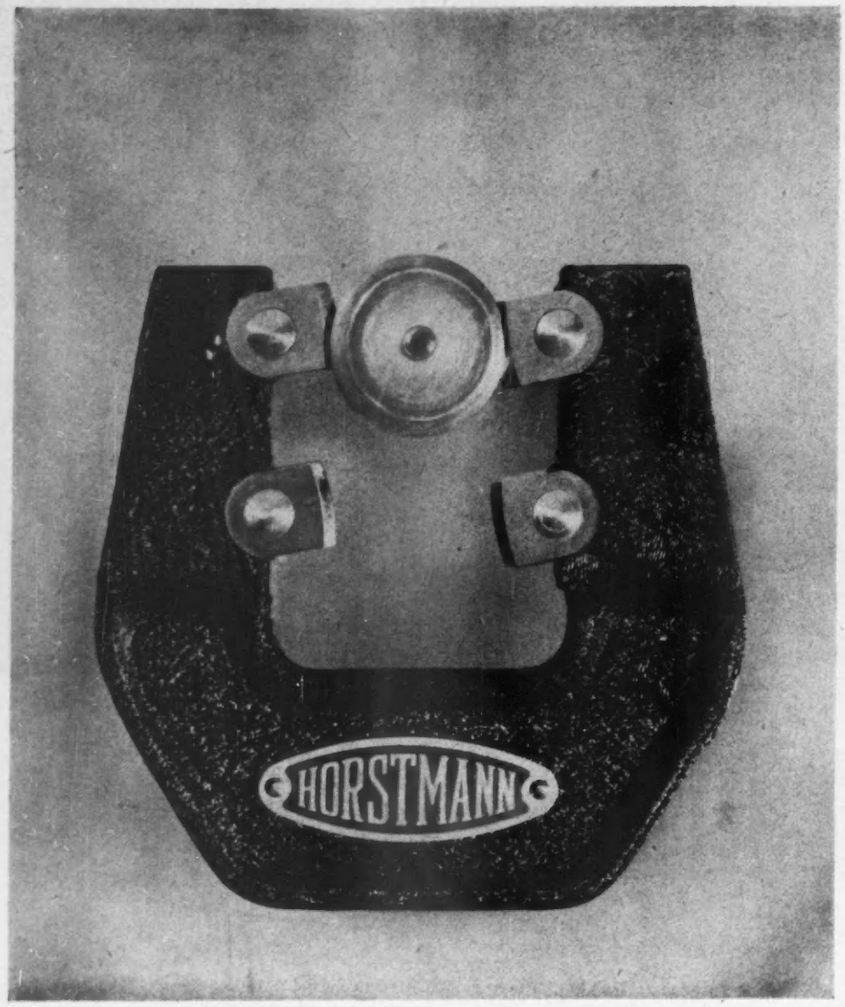

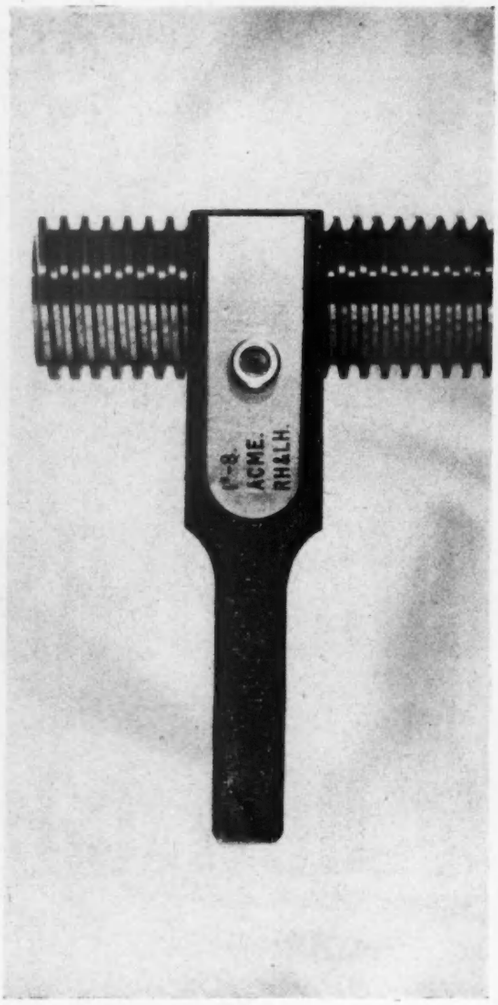

Horstmann—A gauge of accuracy

And—for good measure—the Horstmann Model 52 Screw Caliper Gauge incorporates several features which make it versatile, easy to handle and long-lasting.

One of its advantages (as can be seen from the illustration) is that the depth of anvil section makes the Caliper particularly suitable for gauging Acme forms of thread.

Adjustment can be made simply, to meet the different fits and allowances around a nominal thread size and to present alternative thread sectors to the work when wear eventually takes place. The anvil, designed as a section of a large diameter threaded cylinder, prevents shearing of soft work and makes the Horstmann Model 52 ideal for gauging narrow angle threads. The absence of projections from the side of the Caliper frame enables shouldered work to be gauged easily. These anvils do not rotate in use and are suitable for left and right-hand threaded workpieces. The Caliper is normally supplied as a ' GO ' and ' NOT GO ' combination gauge so that both tests can be applied in one action, but is also available as ' GO ' only or ' NOT GO ' only.

It is manufactured in all common thread forms and STOCKED in many standard diameters.

Horstmann also make screw or plain Plug and Ring type gauges. All these precision instruments are guaranteed for accuracy, hardness and finish to the requirements laid down by the National Physical Laboratory and British Standards Institution.
We shall be delighted to send you descriptive leaflets.

HORSTMANN

PLUG, RING & CALIPER GAUGES
put accuracy in your hands.

THE HORSTMANN GEAR COMPANY LIMITED
NEWBRIDGE WORKS, BATH, ENGLAND, Tel : 7241

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BY "HERCULES"!

(REGD. TRADE MARK)

A REMARKABLE HOSE FITTING

Firms and Organisations like Shell, I.C.I., British Railways, The National Coal Board, etc., find this the perfect Fitting for mending and joining rubber hose of all diameters. You simply fit hose ends over the nozzles and hammer the Claw-Grips home. A "HERCULES" Repairer — and a hammer—is a complete Hose mending outfit, and is only one in the low-cost, efficiency range of "HERCULES" Fittings. *Have us send you full details and prices.*

NEEDS NO CLIPS, CLAMPS, WIRES *nor* SPECIAL TOOLS

The "HERCULES" range includes Hose Repairers, Screw Couplings, Adaptors, etc., for pneumatic, oxy-acetylene and all industrial Hose, and a stronger Lug-type Coupling for suction and delivery hose.

HERCULES SIMPLY HAMMER IT

WON'T LET HOSE SLIP

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THE SPECIALISTS IN HOSE FITTINGS

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Centrifugal Pumps
selfpriming
up to 26 feet vertically
for SEWAGE and SLUDGE

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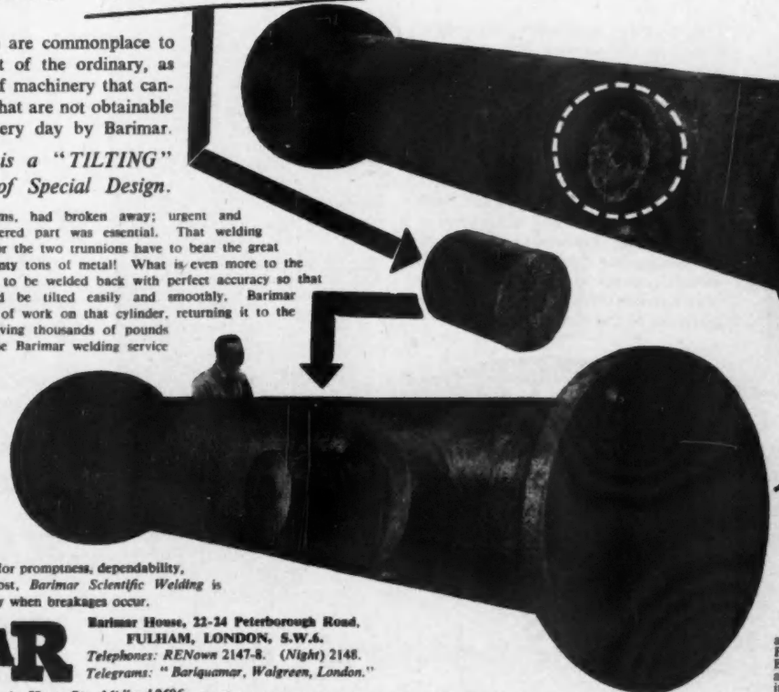
A Grand BARIMAR Repair to a "Tilting" Cylinder SAVED THOUSANDS OF POUNDS

UNUSUAL welding jobs are commonplace to Barimar. Jobs quite out of the ordinary, as well as damaged pieces of machinery that cannot be replaced or parts that are not obtainable promptly, are tackled every day by Barimar.

HERE, for instance, is a "TILTING" Cylinder of Special Design.

One of the trunnions, or arms, had broken away; urgent and *guaranteed* welding of the severed part was essential. That welding simply *had to be Guaranteed*, for the two trunnions have to bear the great weight of the cylinder plus twenty tons of metal! What is even more to the point, the broken trunnion had to be welded back with perfect accuracy so that after repair the cylinder could be tilted easily and smoothly. Barimar expert welders did a grand job of work on that cylinder, returning it to the owners in less than a week, saving thousands of pounds for customers who have used the Barimar welding service over a long period of years. One picture shows the finished job covered, as is the case with *all* Barimar repairs, with the Barimar Money-back Guarantee.

Barimar customers are well aware that a Barimar repair is not only as strong and as efficient as a new part, but frequently more dependable than when the machinery was new! Experience has taught them that for promptness, dependability, and a considerable saving in cost, *Barimar Scientific Welding* is unrivalled and the sturdy stand-by when breakages occur.



"Tilting" Cylinder with broken trunnion. The cylinder carried a load of twenty tons!

Guaranteed BARIMAR

The Cylinder repaired, IN LESS THAN A WEEK, under *the* Barimar Money-back Guarantee, *is now as strong as ever.*

● ALL BROKEN PARTS which are transportable must be sent CARRIAGE PAID or delivered to the nearest Barimar Branch address. Please remove all fittings and post letter advising dispatch. When it is impossible to transport the damaged machinery Barimar experts will operate ON THE SPOT.

BARIMAR LTD.

Barimar House, 22-24 Peterborough Road, FULHAM, LONDON, S.W.6.
Telephones: RENown 2147-8. (Night) 2148.
Telegrams: "Bariquamar, Walgreen, London."

BIRMINGHAM, 12: 116-117, Charles Henry St. *Midland 2696*
NEWCASTLE UPON TYNE, 1: 64-66, The Close. *Tel. 21055*
GLASGOW, C.2: 134, West George Lane. *Central 4709*

BARIMAR—The World's Scientific Welding Engineers

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LOOSE NUTS LOSE MONEY

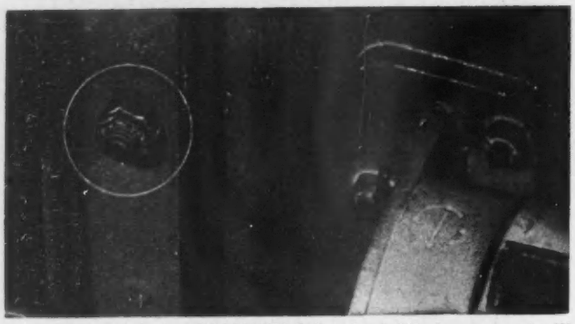
'PALNUT'

(REGD. TRADE MARK)

SAFETY LOCK WASHERS

ECONOMICALLY AND EFFICIENTLY DEFY VIBRATION

BY COURTESY OF BRITISH RAILWAYS, SOUTHERN REGION, WE SHOW BELOW A 'PALNUT' FITTED TO THE ROOF OF A MAIN LINE DIESEL LOCOMOTIVE.



We are sure that the 'PALNUT' Safety Lock Washer can and will be of service to you—give us a chance to prove it.

Available in all threads from 6 B.A. to 3" B.S.F. **'PALNUTS'** give a guaranteed and easily inspected lock. Function on short bolt lengths and dispense with all need for drilling or distortion of thread.

NATIONAL PHYSICAL LABORATORY TESTED

THE GREATER THE VIBRATION THE TIGHTER THE GRIP

For further details apply

THE PALNUT COMPANY LTD.

(Est. 1919)

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Telegrams : PALNUT HOVE. *Tele : 70427.*

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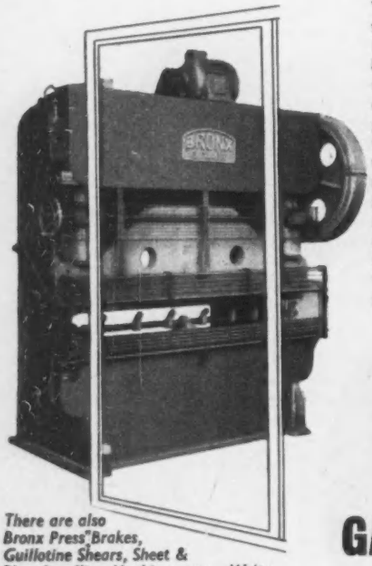
Specially designed . . .
for Punching and Notching
METAL WINDOW BARS



There are also Bronx Press Brakes, Guillotine Shears, Sheet & Plate Levelling Machines, etc. Write for Catalogues.

This machine has been developed from the well-known Bronx 60-ton Press Brake, and incorporates an 8 ft. long beam, which has a stroke of 3½ in. and a vertical adjustment of ¼ in., by hand, through worm gearing. A distance of 7 in. is provided between the beam and the bed, with the stroke down and adjustment up. The operating speed is 40 strokes per min. and the cycle is automatically started by the action of closing the guard by hand. A stroke counter and a dial indicator, which shows the bottom dead-centre position of the beam, are fitted.

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GANG PUNCHING PRESS

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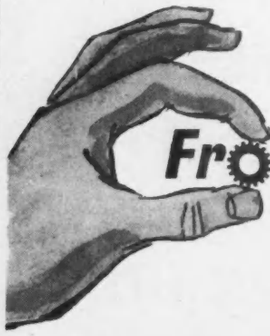

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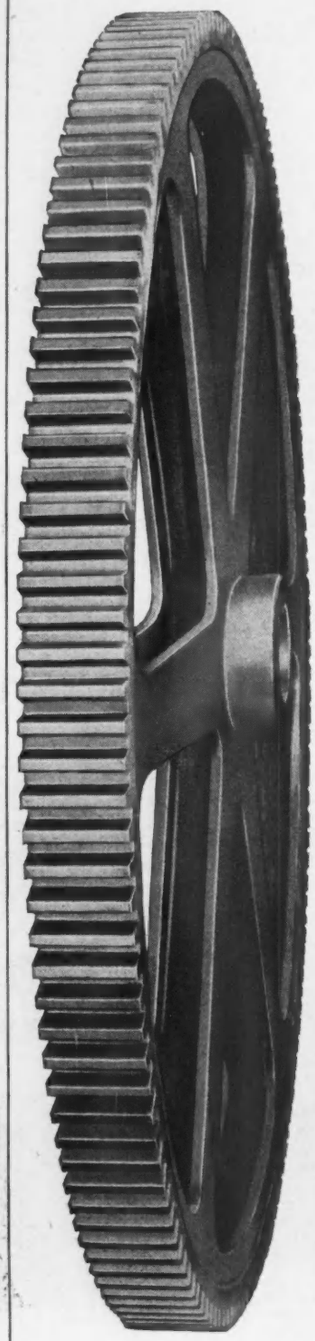
GIANTS

we know a lot about gears



Spurs, Worms, Helicals, Spirals . . . in fact, all shapes and sizes up to 10 ft. diameter.

Ask for details about complete supply or for teeth cutting only.

With our reply we will be pleased to send you a copy of our booklet giving useful gear data.

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SINGLE AND DOUBLE HELICALS
BEVELS (STRAIGHT AND SPIRAL)
WORM GEARS
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RACKS, ETC.

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PENDLETON GEAR WORKS
MANCHESTER 6.

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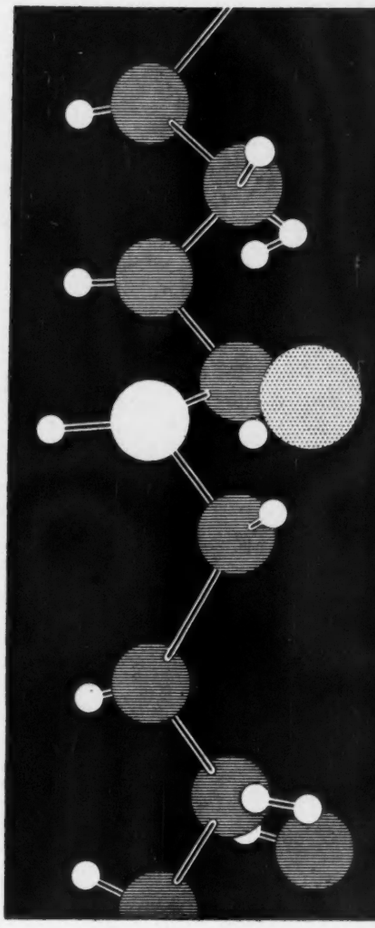

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NYPAC

CONVEYOR BELTING

GREATER TENSILE STRENGTH
IMPROVED IMPACT RESISTANCE
REDUCED WEIGHT
INCREASED FLEXIBILITY
BETTER TROUGHING
IMPROVED TEAR RESISTANCE
BETTER FASTENER ANCHORAGE
PERMITS SMALLER DRUM DESIGNS

BTR announce the availability of a *complete range* of conveyor belts with performance markedly superior to heavier constructions employing highest quality cotton duck. The nylon-wefted fabrics incorporated in Nypac belts ensure increased economies — in whatever industry they operate.

BTR

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BRITISH THERMOPLASTICS & RUBBER MANUFACTURERS
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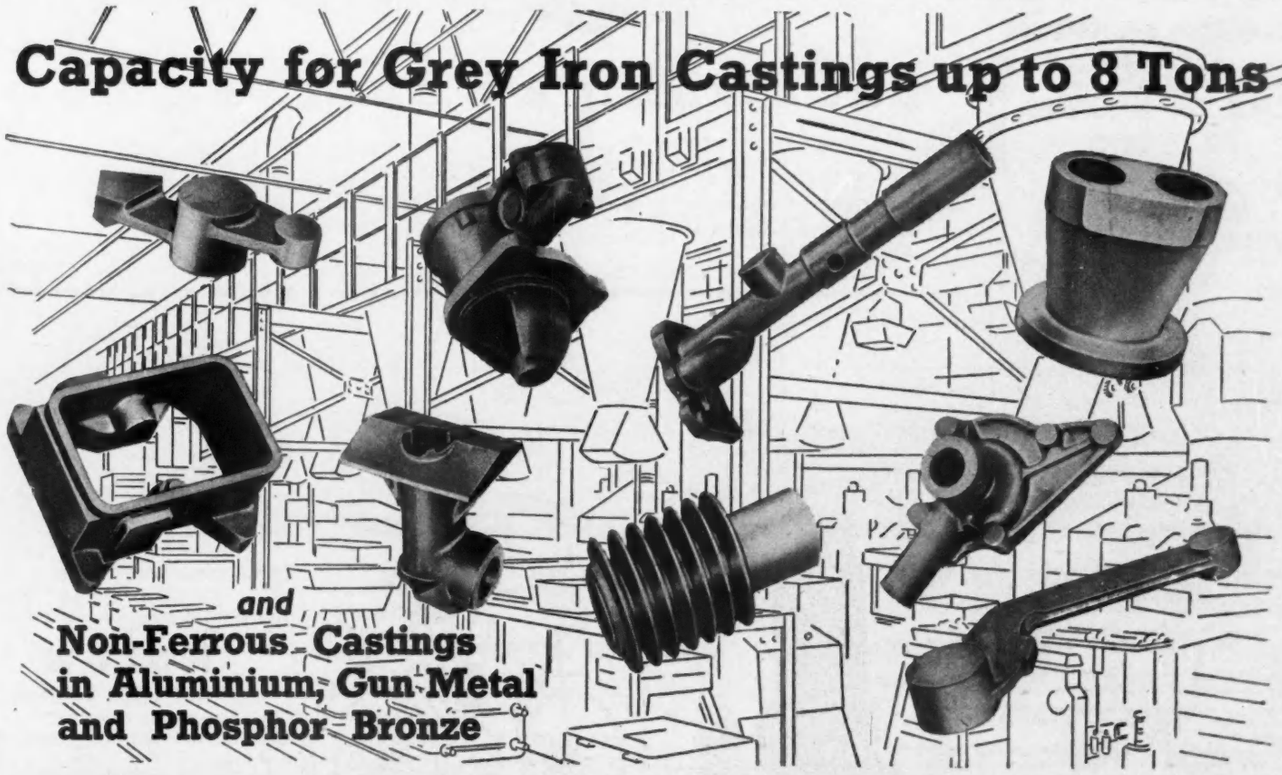

and
Non-Ferrous Castings in Aluminium, Gun Metal and Phosphor Bronze

JOHN HILL & SONS (Ironfounders) LTD

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ALBION WORKS, HORSELEY FIELDS, WOLVERHAMPTON. *Tel: Wolverhampton 23445/6 & 24981.*

● PATTERN SHOP AND MACHINE SHOP SERVICE IS ALSO AVAILABLE.

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INDUSTRIAL COUNTING INSTRUMENTS and MEASURING MACHINES

Let us solve your counting and measuring problems

Write or phone for our Catalogue or a visit from a technical representative to "INSTRUMENT DIVISION"

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Grams: "BRAIDERS BOLTON"

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HAMMERED OR HYDRAULIC PRESSED

FORGINGS

IN STEEL
BLACK OR MACHINED
TO 24 TONS

THE INCE FORGE CO. LTD.
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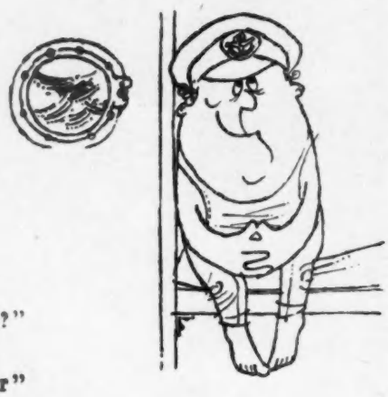

"Just listen to that beat"

"Marvellous!"

"Ever hear anything so smooth and solid?"

"Never"

"Makes the old feet tap, don't it?"

"W-e-l-l . . . I suppose it does"

"Never been a band like it"

"Band? I thought you were talking about the engines since we fitted L & C Piston Rings!"

LOCKWOOD & CARLISLE LTD

Manufacturers of the well known "Patent Double Action Piston Rings" for steam engines

MAKERS OF THE WORLD'S FINEST DIESEL PISTON RINGS

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Clean Feed Water
means higher boiler efficiency and lower fuel costs!

Feed water that deposits scale on boiler heating surfaces is a prime cause of overheating and subsequent tube collapse. And, remember, the majority of town water supplies, as well as sea-water, are heavy depositors of scale.

A Caird & Rayner Evaporator takes all the harm out of sea-water and provides a full supply of clean feed water to the boilers.

Not only is boiler efficiency raised and maintenance reduced appreciably, but substantial fuel savings will be seen as well.

Evaporators can be supplied to cope with feed water to any required rate. Further details will gladly be supplied on request.

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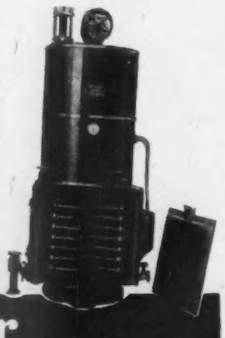

Caird & Rayner LTD
777 COMMERCIAL ROAD LONDON E 14

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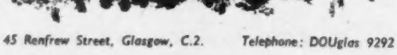
Bone shaking vibration can slacken the tightest nut. The way to smooth your worries is to fit KOLOK Positive Lock Washers. They come in every size.

KOLOK
POSITIVE LOCK WASHERS
(AVAILABLE IN ALL SIZES)



POSITIVE LOCK WASHER CO. LTD. 45 Renfrew Street, Glasgow, C.2. Telephone: DOUglas 9292

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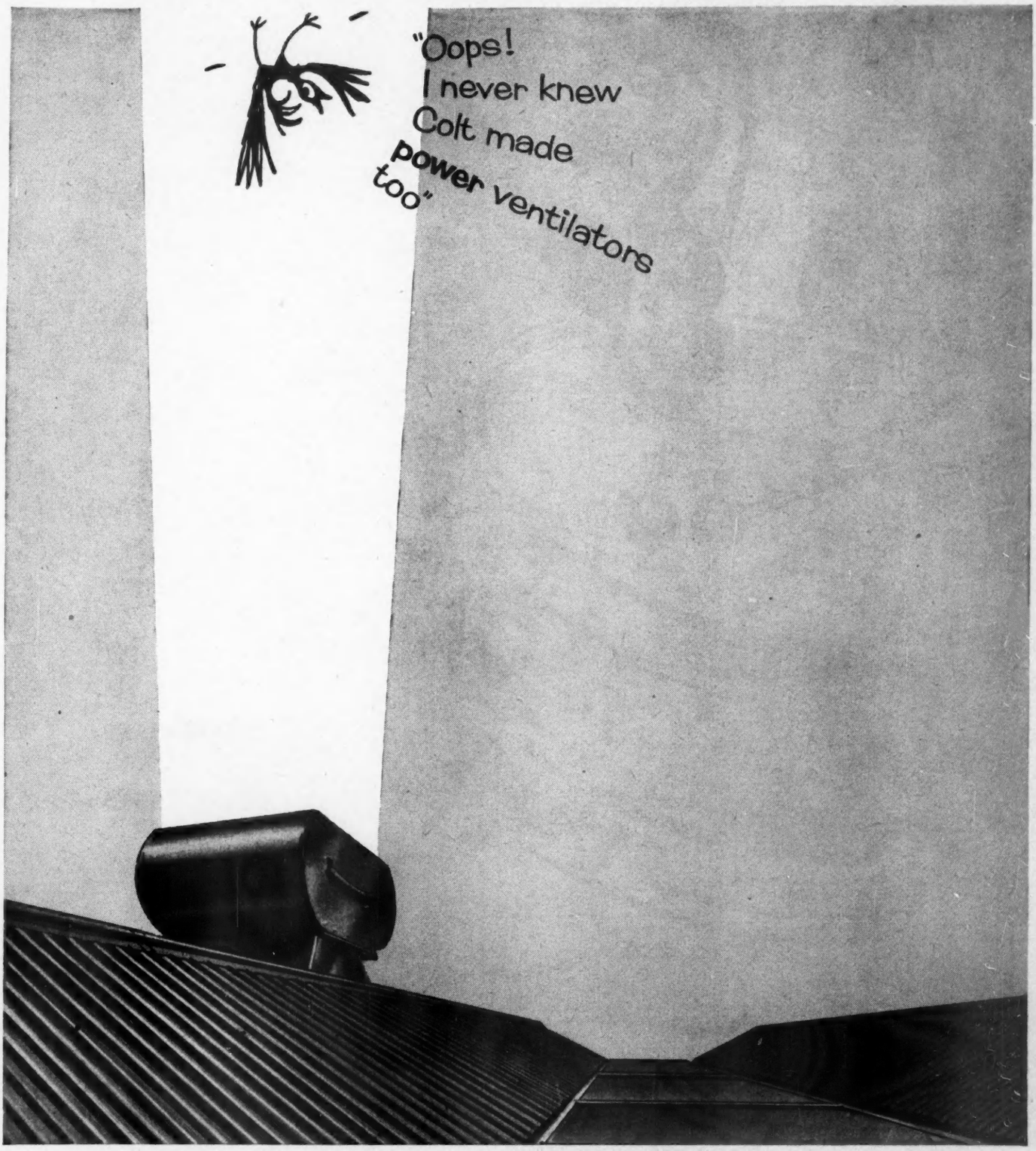

They do! Colt have a ventilator, natural or powered, to meet every kind of problem—including a range of high powered ventilators such as the Upward Discharge unit shown here. Let the Colt Ventilation Service advise you. Powered or natural, or a combination of both—the Colt engineer will tell you which system is best and most economical for you. Send for a manual to Dept. S37/1b

COLT

The power behind natural ventilation and naturally behind powered ventilation too!

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Calypso for the Cane Harvest

The sugar harvest is in . . . speeded by Hudson Light railway and trailer equipment. In the West Indies, as in every part of the world, Hudsons have gained experience over many years of the type of equipment most suited to the bulk movement of crops and of minerals both above and below the ground.

This experience adds progressively to new developments and improvements in equipment to the benefit of users everywhere.

Hudson
LIGHT RAILWAY MATERIALS

ROBERT HUDSON, LTD.
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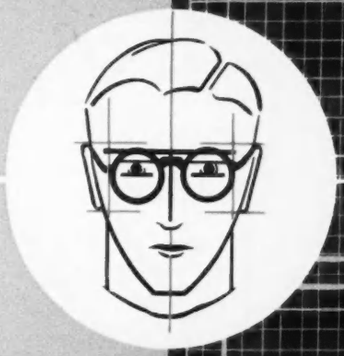

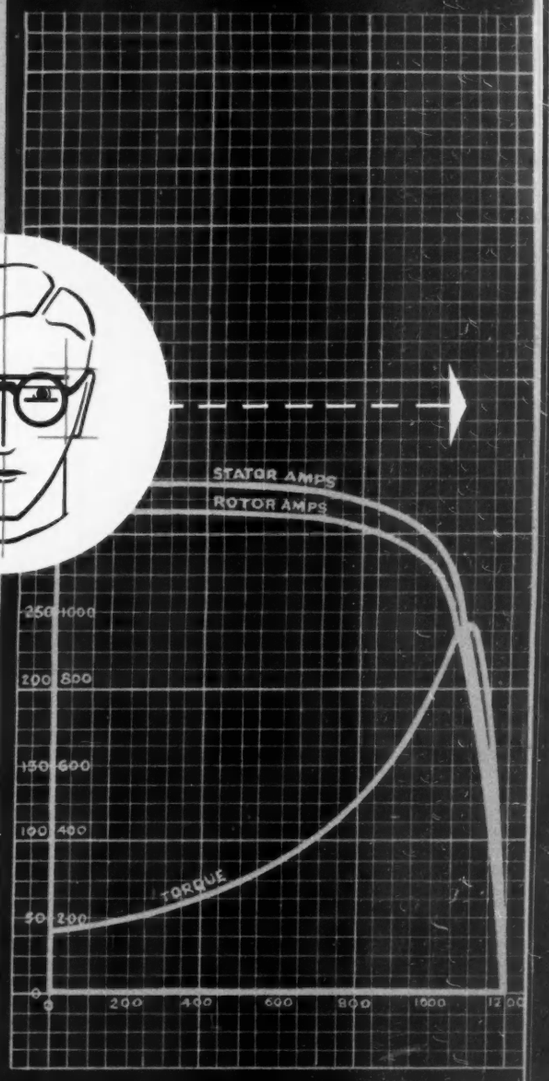

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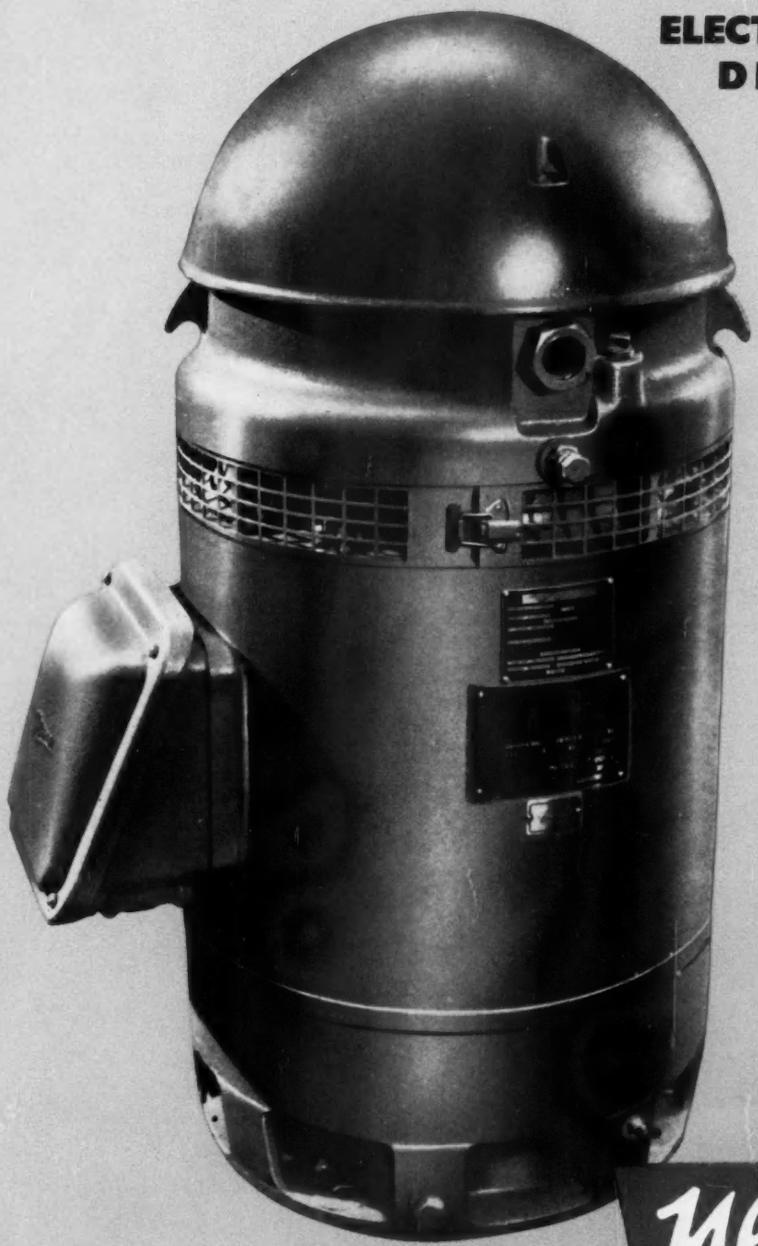

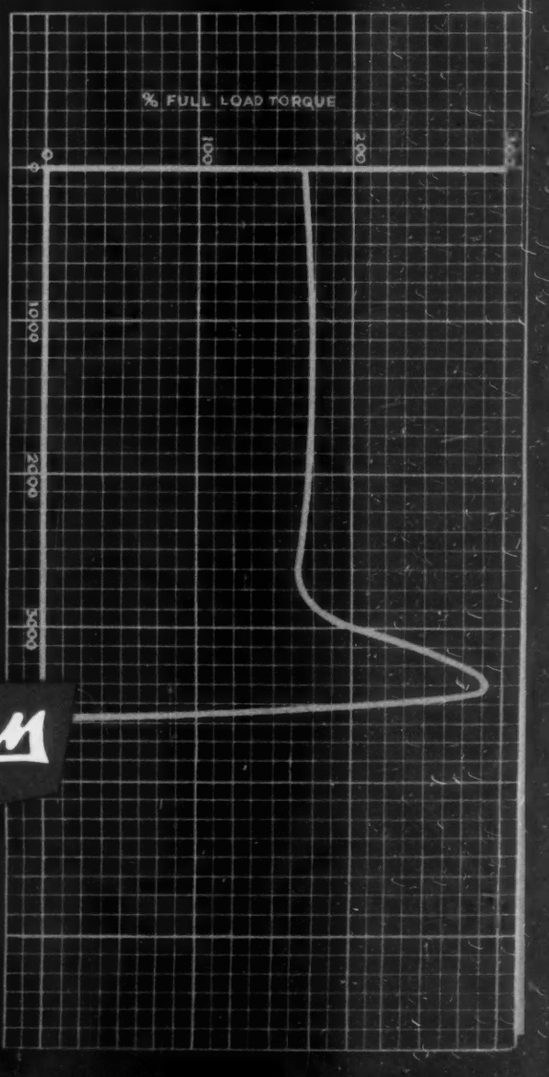

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Calypso for the Cane Harvest

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This experience adds progressively to new developments and improvements in equipment to the benefit of users everywhere.

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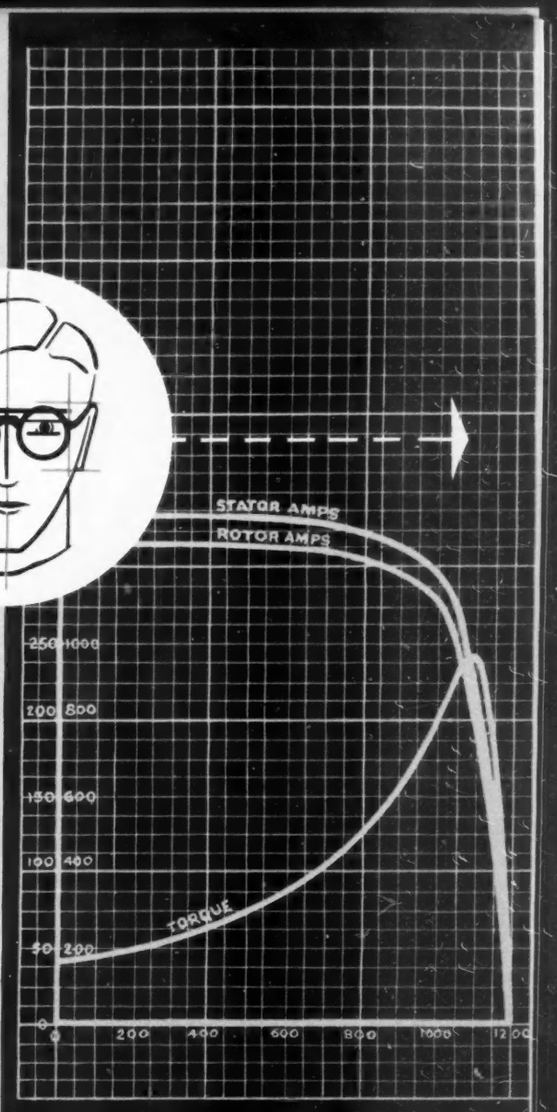
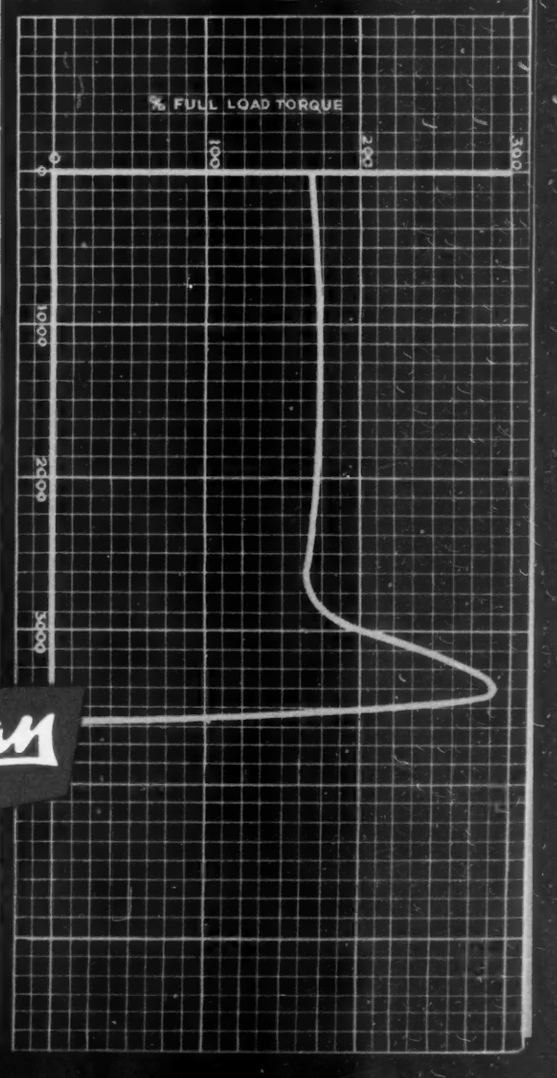


ELECTRICAL DESIGN



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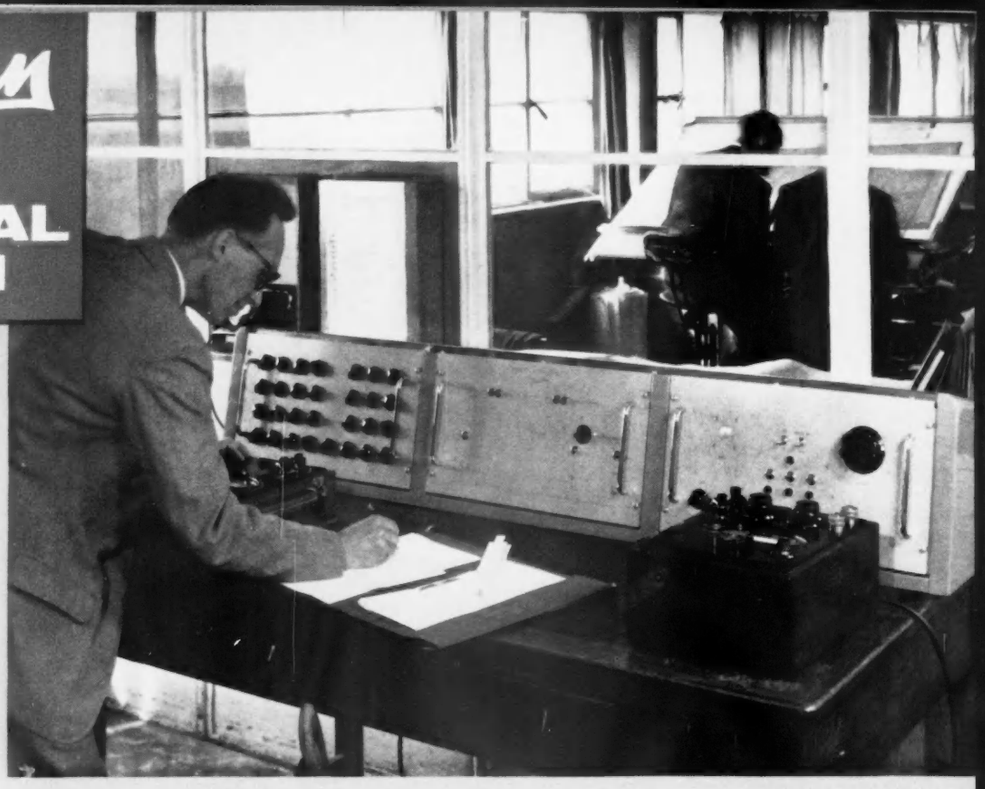


'NIMS'—The Newman Induction Motor Simulator—an electronic instrument designed and built by the Newman Instrument Division—being used by one of the Company's electric motor Designers to speed up essential design calculations.

Electrical design is that part of designing which determines the performance characteristics of an electric motor; depending largely upon the designers skill in assessing a large number of variable and interdependent factors in the light of the work to be done by a motor. These variables begin with the obvious details such as horsepower, speed, full load current, torque, temperature rise, overload capacity, slip, efficiency, power factor—all interrelated with each other. But the job is not just one of theory or set formulæ, for once the assessment is made it must be translated into practical terms—the exact form, size and method of producing the windings and the materials to be used, the precise shape of the rotor slots and the composition of the laminations, the insulation materials and techniques. In addition the electrical designer must have a wide knowledge of general engineering in order to understand the demands of a particular motor application, be something of a production engineer, as well as an economist to keep his designs 'down-to-earth' in cost.

We have taken one aspect of electrical design—rotor slot design—to show how this influences the torque, current and slip characteristics of an electric motor for a number of different applications. It is in the every-day application of principles like these to new problems that the value of Newman experience and knowledge lies.

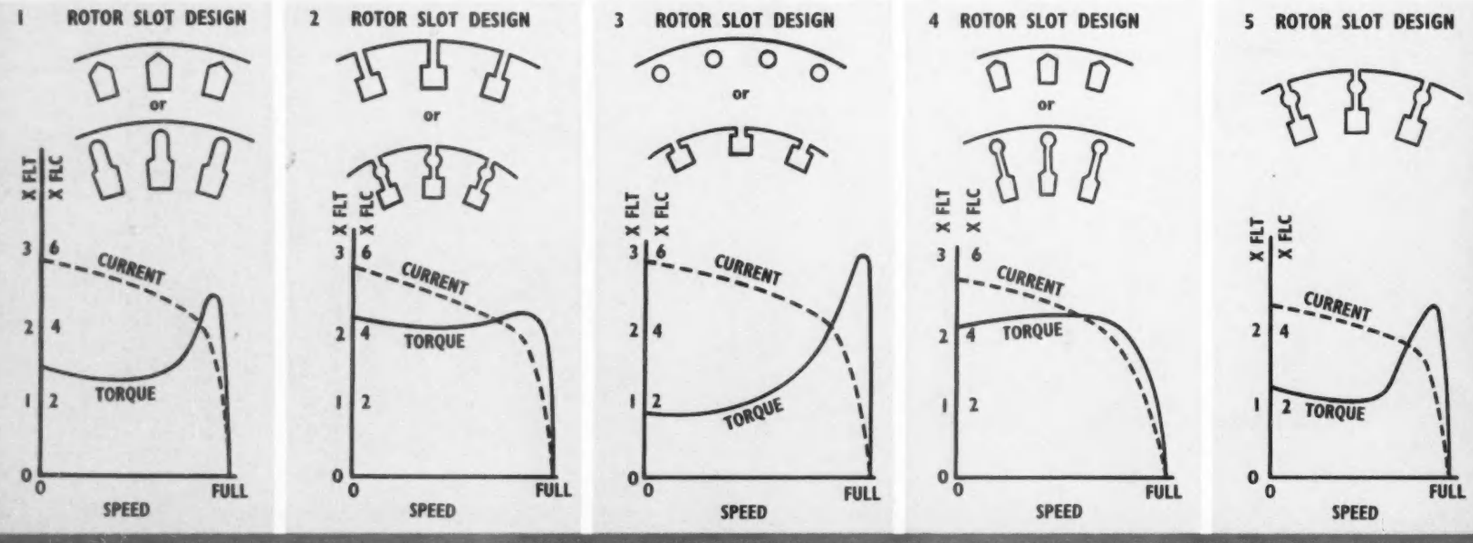
1 The motor suitable for the majority of drives would have a starting torque of 150% full load torque, a breakdown torque of 250% FLT, a starting current of 600% FLC and a full load slip of about 2.5%.

2 Some drives, e.g. conveyors, coal pulverisers, hammer mills etc. require a high starting torque so the general purpose motor is not suitable. Torques of 200-250% FLT can be obtained by using a high resistance rotor bar material, a 'sash bar' or double cage rotor design. The starting current would still be 600% FLC approx.

3 For rolling mill drives and high torque loads connected through fluid couplings the starting torque required is quite low but the breakdown torque should be as high as possible.

4 Machines like guillotines and presses which incorporate flywheels in the moving system so that their kinetic energy can be extracted when required, need a high full load slip, say between 5 and 13% as well as a high starting torque. This demands a high resistance rotor.

5 In many instances the normal direct-on-line starting current of 600% FLC is too high for the customer's supply system and currents of about 450% FLC with torques of 100-130% FLT are required. This normally necessitates a double cage rotor.



Newman

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EXTERNAL COMPACTNESS

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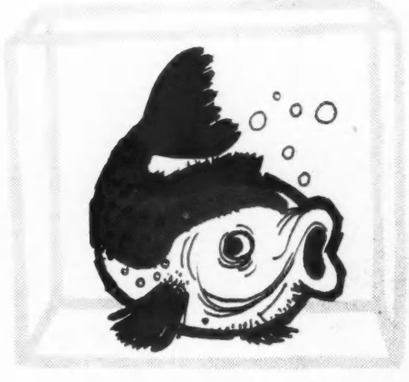
boilers



tanks

coolers

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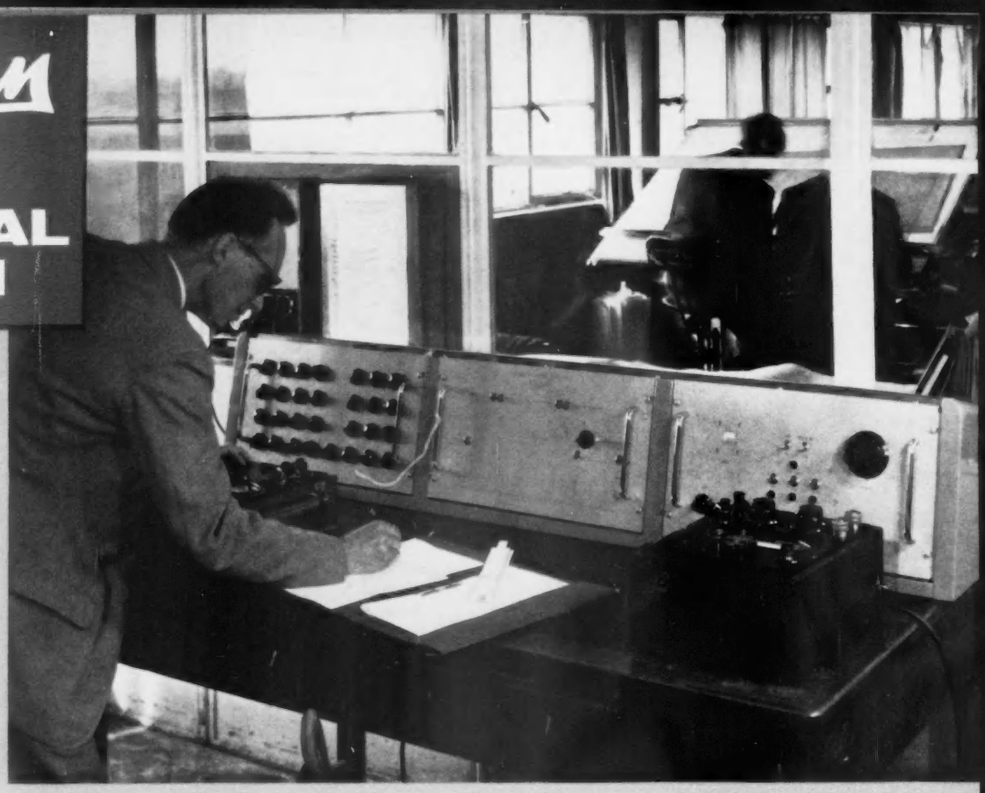
Newman

ELECTRICAL DESIGN



'NIMS'—The Newman Induction Motor Simulator—an electronic instrument designed and built by the Newman Instrument Division—being used by one of the Company's electric motor Designers to speed up essential design calculations.

Electrical design is that part of designing which determines the performance characteristics of an electric motor; depending largely upon the designers skill in assessing a large number of variable and interdependent factors in the light of the work to be done by a motor. These variables begin with the obvious details such as horsepower, speed, full load current, torque, temperature rise, overload capacity, slip, efficiency, power factor—all interrelated with each other. But the job is not just one of theory or set formulæ, for once the assessment is made it must be translated into practical terms—the exact form, size and method of producing the windings and the materials to be used, the precise shape of the rotor slots and the composition of the laminations, the insulation materials and techniques. In addition the electrical designer must have a wide knowledge of general engineering in order to understand the demands of a particular motor application, be something of a production engineer, as well as an economist to keep his designs 'down-to-earth' in cost.

We have taken one aspect of electrical design—rotor slot design—to show how this influences the torque, current and slip characteristics of an electric motor for a number of different applications. It is in the every-day application of principles like these to new problems that the value of Newman experience and knowledge lies.

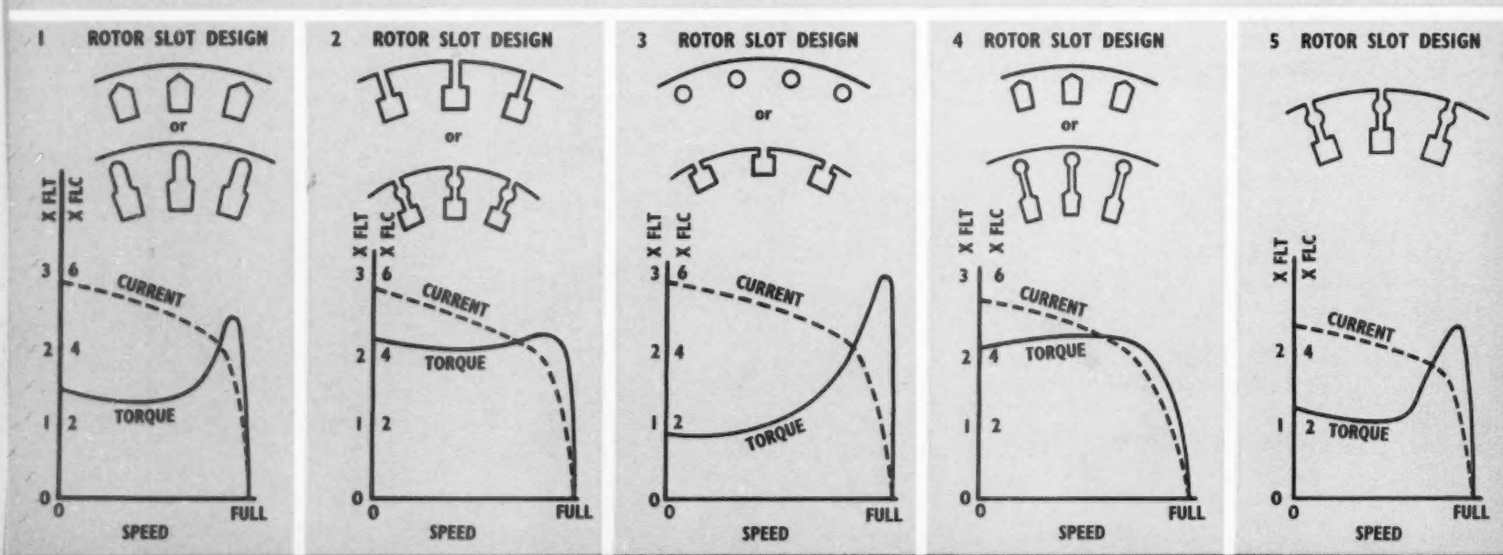
1 The motor suitable for the majority of drives would have a starting torque of 150% full load torque, a breakdown torque of 250% FLT, a starting current of 600% FLC and a full load slip of about 2.5%.

2 Some drives, e.g. conveyors, coal pulverisers, hammer mills etc. require a high starting torque so the general purpose motor is not suitable. Torques of 200-250% FLT can be obtained by using a high resistance rotor bar material, a 'sash bar' or double cage rotor design. The starting current would still be 600% FLC approx.

3 For rolling mill drives and high torque loads connected through fluid couplings the starting torque required is quite low but the breakdown torque should be as high as possible.

4 Machines like guillotines and presses which incorporate flywheels in the moving system so that their kinetic energy can be extracted when required, need a high full load slip, say between 5 and 13% as well as a high starting torque. This demands a high resistance rotor.

5 In many instances the normal direct-on-line starting current of 600% FLC is too high for the customer's supply system and currents of about 450% FLC with torques of 100-130% FLT are required. This normally necessitates a double cage rotor.



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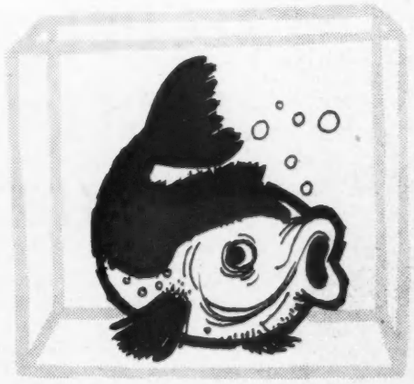
boilers



tanks

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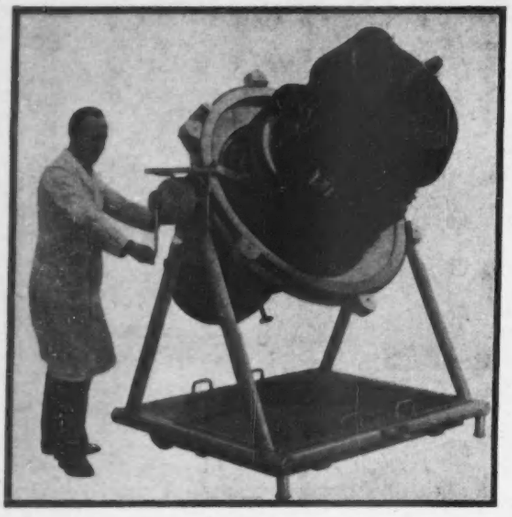
STRATELINE SPEED REDUCERS



The photograph above shows the type CW1 Strateline unit fitted to a Rolls Royce Dart Aero Engine Overhaul Stand designed and manufactured by Messrs. Morfax Limited of Mitcham, Surrey. The high efficiency and compact assembly of the Strateline makes it particularly suitable for manual operation and many variations have been supplied for high pressure valve operation, hand winch units, furnace tilting, etc. Where reasonable quantities are involved we are prepared to design special units against particular applications.

- This Strateline unit has an output capacity of 7,000 lbs. ins. required by maximum out of balance conditions whilst working on the Engine.
- The ratio illustrated is 60:1 but ratios between 20:1 and 100:1 are provided by the hypocycloidal gearing.
- Self-sustaining Strateline mechanism which operates when movement of handle ceases—the engine can be rotated, and sustained at any position, through 360°

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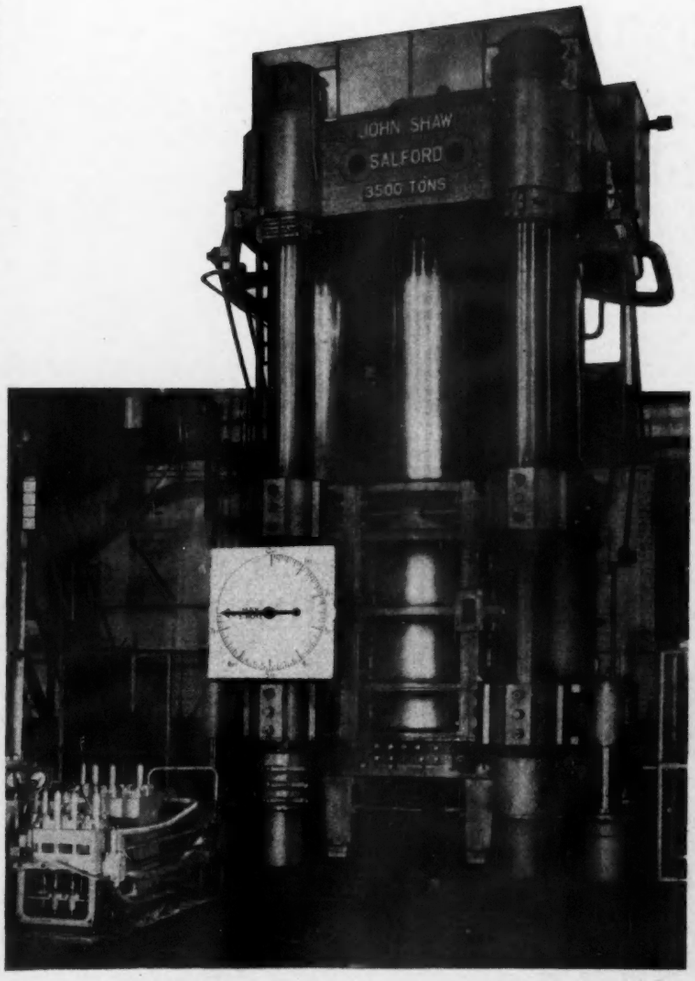

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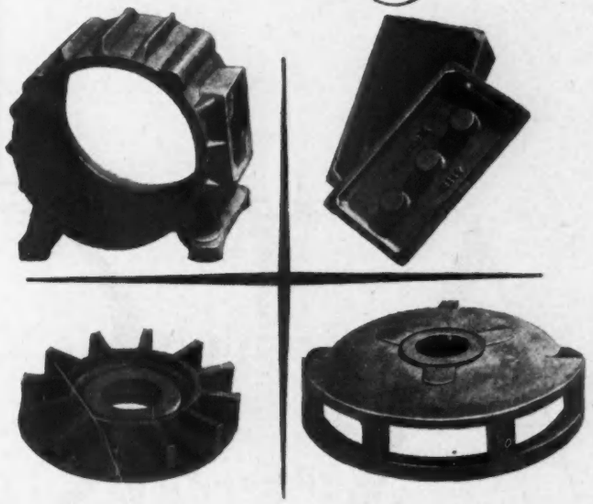

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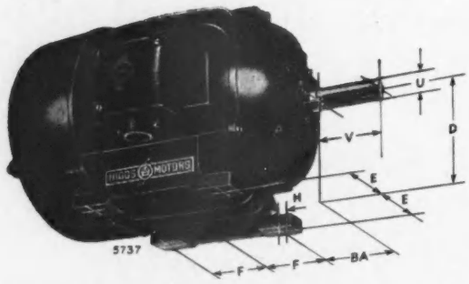

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2	1½	¾	½	D164	4	3½	2½	2½	3/8	½	2½	3/16	3/16
3	2	1	¾	D182	4½	3½	2½	2½	7/16	1½	3	5/16	¼
5	3	2&1½	1	D184	4½	3½	2½	2½	7/16	1½	3	5/16	¼
7½	5	3	2&1½	D213	5½	4½	2½	3½	7/16	1½	3½	¼	¼
10	7½	5	3	D215	5½	4½	3½	3½	7/16	1½	3½	¼	¼
15	10	7½	5	D254	6½	5	4⅛	4½	9/16	1½	4½	7/16	5/16
20	15	10	7½	D256	6½	5	5	4½	9/16	1½	4½	7/16	5/16
25	20	—	10	D284	7	5½	4½	4½	9/16	1½	5½	½	5/16
30	25	15	—	D286	7	5½	5½	4½	9/16	1½	5½	½	5/16
—	30	20	15	D324	8	6½	5½	5½	11/16	2½	6½	⅝	7/16
—	40	25	20	D326	8	6½	6	5½	11/16	2½	6½	⅝	7/16

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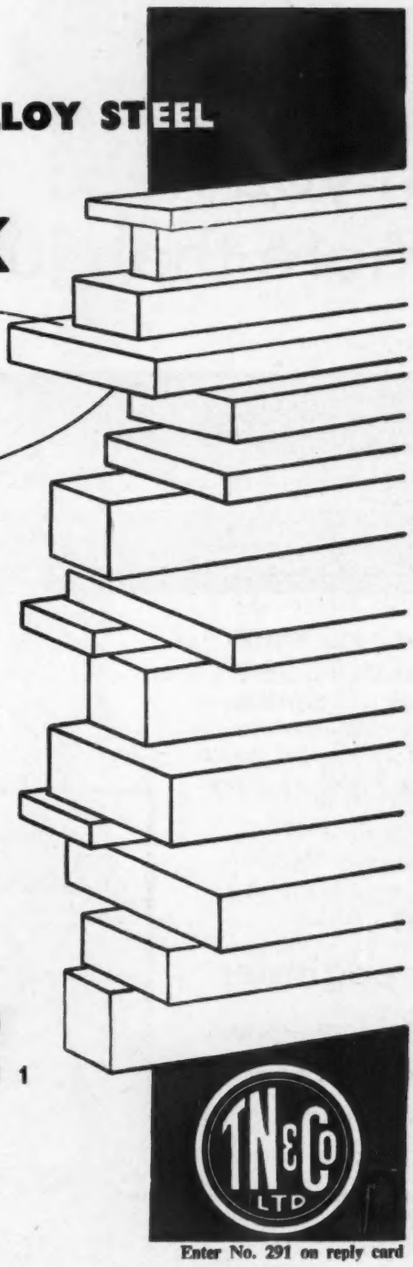

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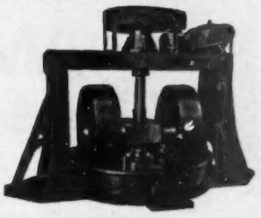

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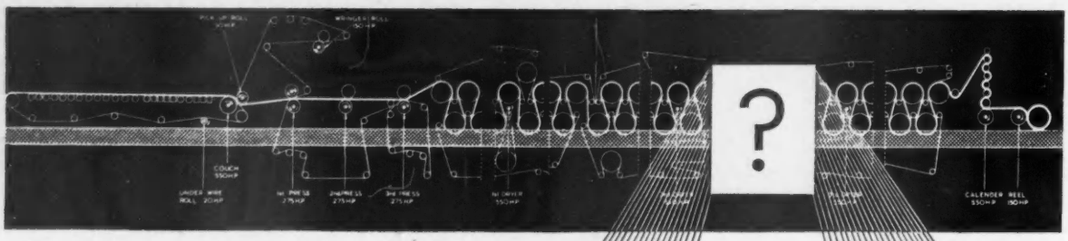

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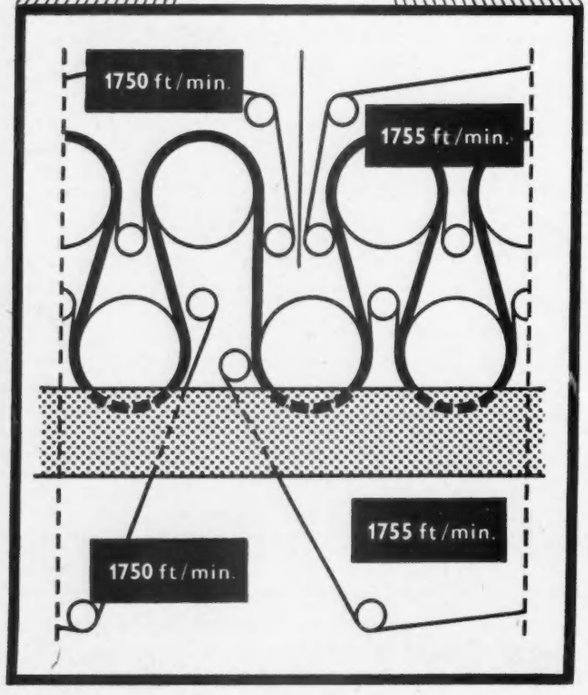
The importance of accurate differential speeds in sectional paper machine drives is one of the many specialised industrial problems of which AEI has extensive practical knowledge.



. . . call in an AEI sales engineer

who specialises in your industry. He understands your particular problems and will ensure that you get drives and control gear designed to meet your exact needs. But his services go far beyond the supply of equipment. He will assist with every aspect of the problem, including layout, integration of related equipment, safety and operational considerations.

AEI **Associated Electrical Industries Limited**
Motor and Control Gear Division
RUGBY & MANCHESTER, ENGLAND

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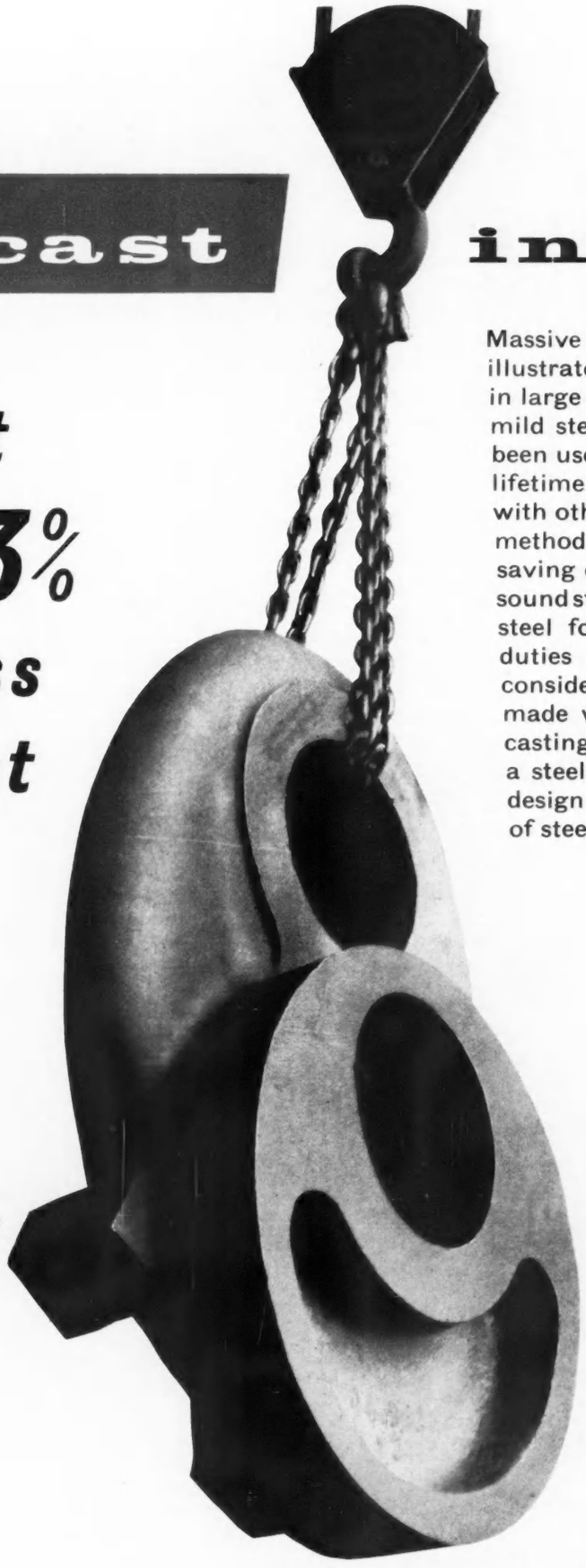

Massive Webs, such as the one illustrated, are cast in steel for use in large Marine Engines. Made in mild steel, similar castings have been used in crankshafts to give a lifetime's service at sea. Compared with other and earlier production methods, they show a direct cost saving of 13% and illustrate how sound steel castings from a modern steel foundry can meet arduous duties at less cost. Have you considered if this economy can be made with your components by casting in steel ?. Why not call in a steel foundry engineer at the design stage and take advantage of steel foundry know-how.

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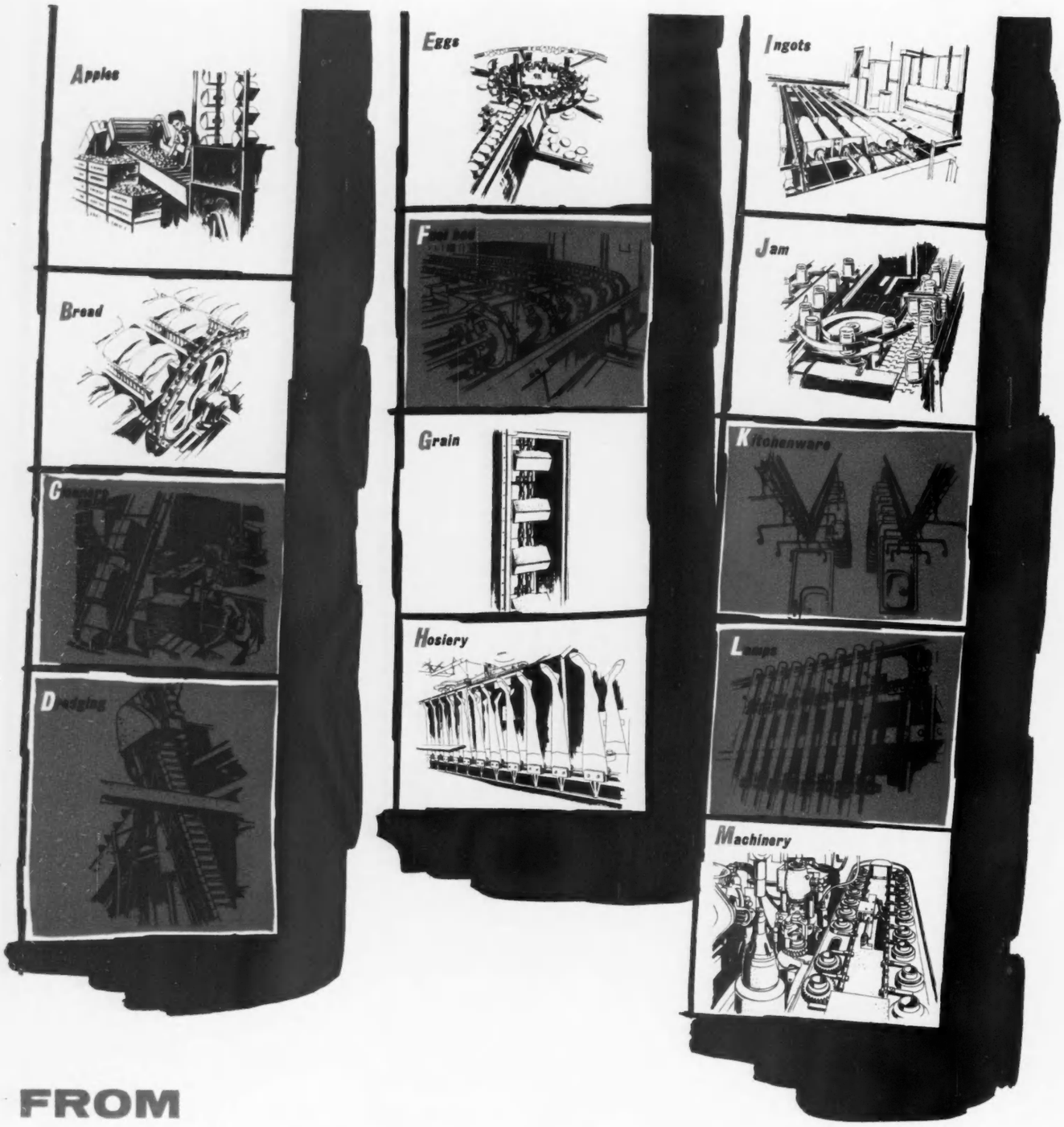

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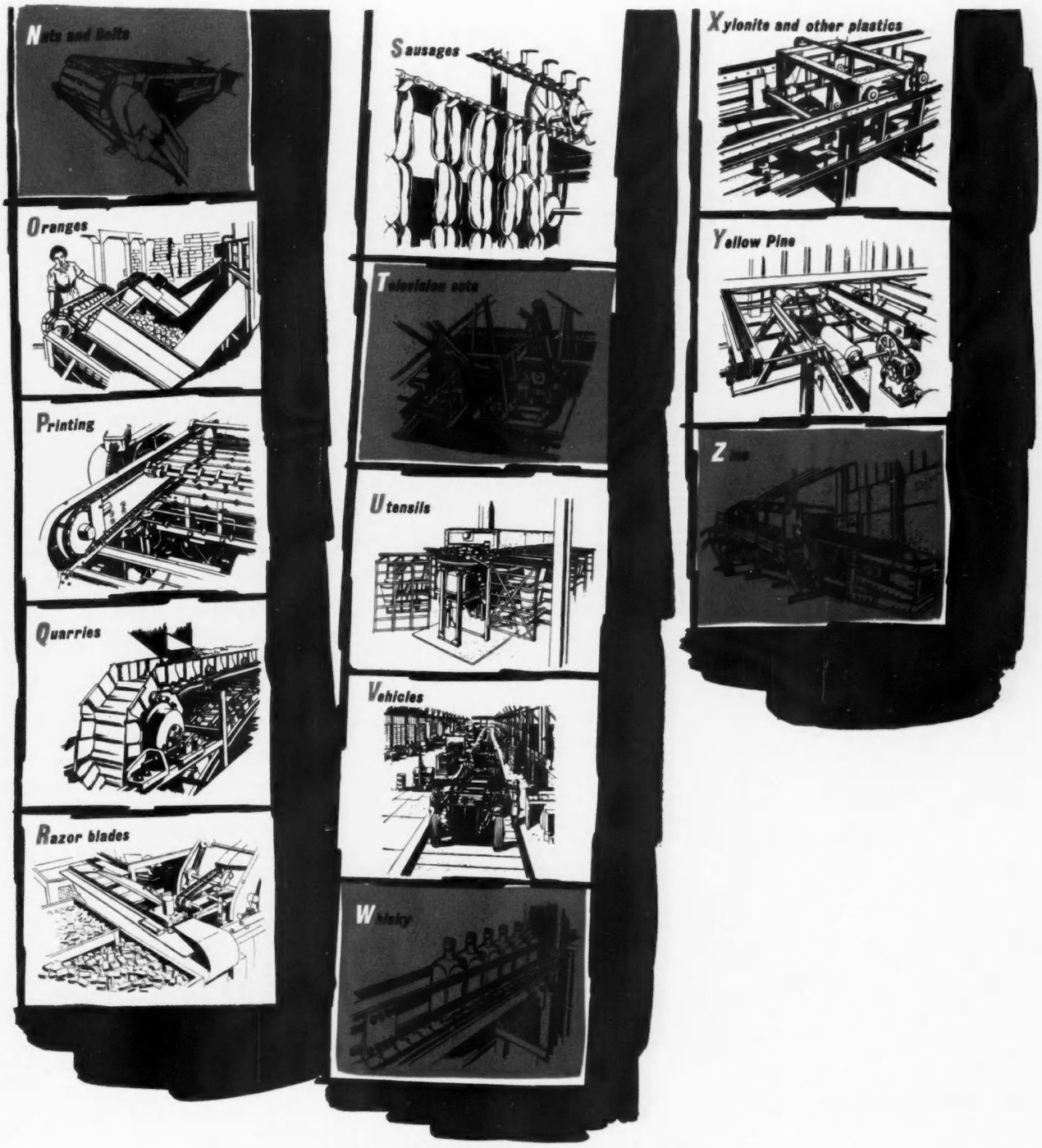

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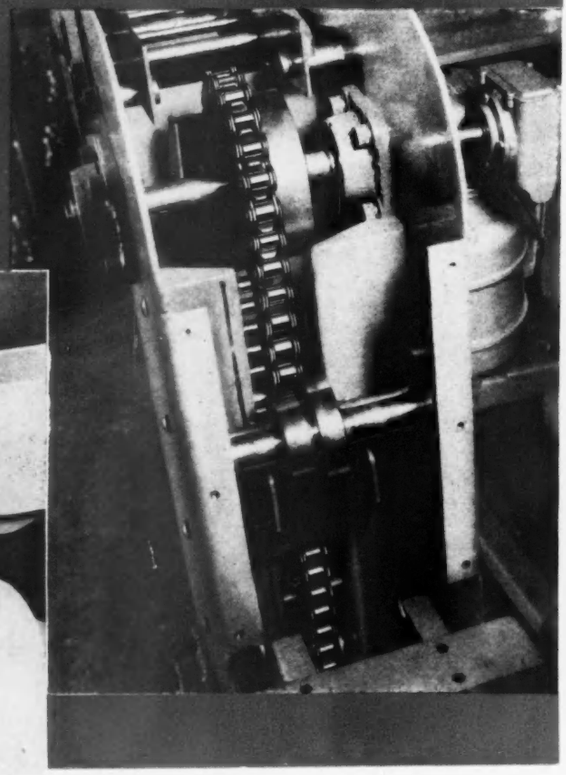
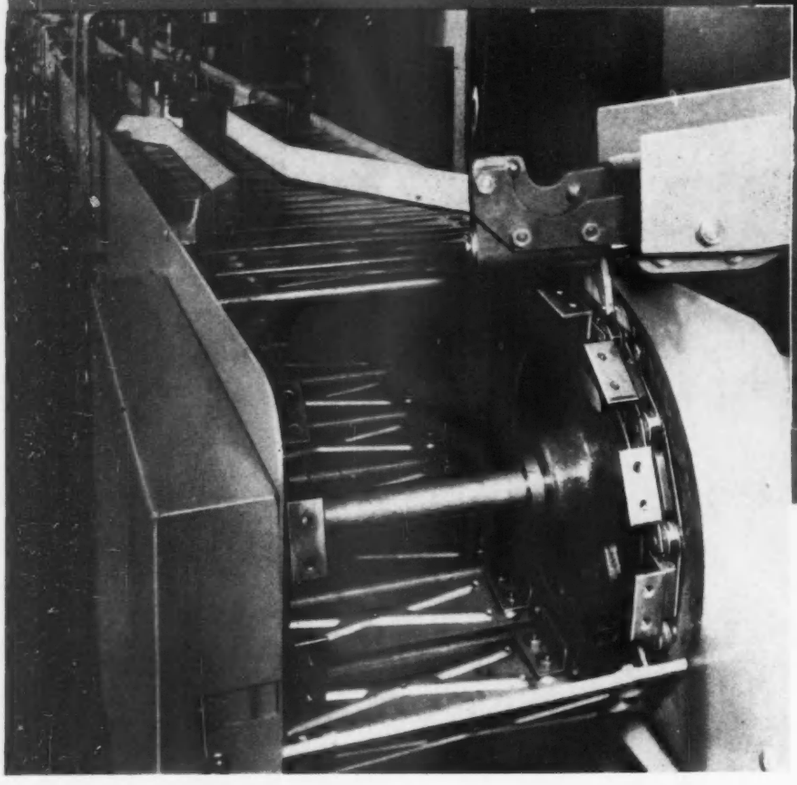
Perry ¾" pitch single roller chain drive and Perry Girder conveyor chain are fitted to the revolutionary Churchill Gear "Link-Line", which represents a major advance in the field of gear production and incorporates machine tools of latest design. The "Link-Line" is completely automatic in operation and processes gears through all stages of gear cutting.





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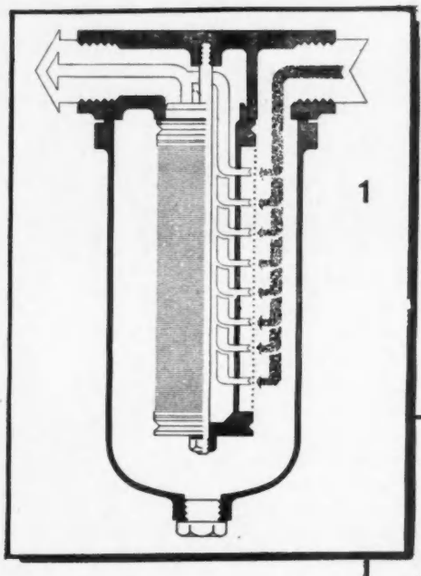
INSIDE INFORMATION

ON MODERN FILTRATION TECHNIQUES



AUTO-KLEAN LOLOS (1)

This is a range of filters incorporating wire-wound elements designed for ultra fine filtration of low to medium viscosity fluids under pressure.

Principle: A ribbed cylindrical former is screw cut, and a continuous monel or stainless steel wire is tightly wound into the grooves. By altering the pitch and/or the diameter of the wire defined alterations of mesh can be accomplished. LOLOS L.F. filters have a fabric sleeve fitted over a fine mesh wire-wound element.

Advantages: AUTO-KLEAN LOLOS filters ensure ultra fine filtration *with negligible pressure loss.* Their robust construction remains non-collapsible under extreme pressures, requiring practically no maintenance. Also important is its small lightweight construction.

Data: Working pressures can be arranged up to 2,000 lb/sq.in. Also included in the range are duplex and multi-element designs.

Typical Applications: Hydraulics; fuel and lubrication systems in air, sea and land transport, cooling circuits; distilleries; irrigation lines; washing and bottling plants, etc.

AUTO-KLEAN FLUSHFLO (2)

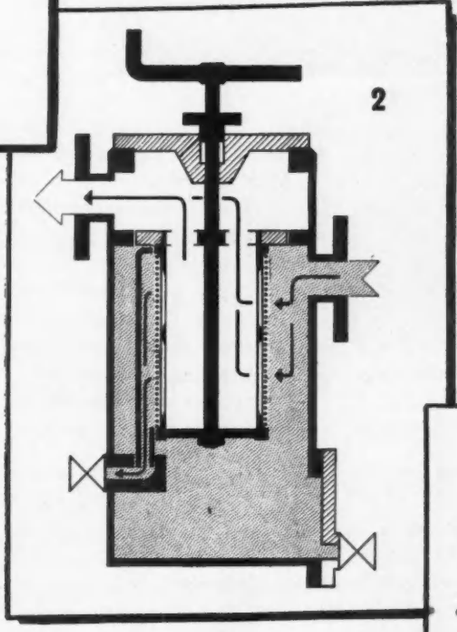
This is a range of self-cleaning filters specifically designed for continuous operation in the cooling and lubricating systems of heavy machinery.

Principle: Sludge collected by a wire-wound element is dislodged by reverse flow, while the filter element is electrically or manually turned. In contact with the wire element is a spring-loaded slotted tube which acts simultaneously as 'scraper' and discharge passage.

Advantages: The FLUSHFLO is completely self-cleaning while in service without interruption of liquid flow. It ensures fine, positive full-flow filtration with very low pressure losses. And, because the sludge is removed automatically without dismantling, its use leads to reduced maintenance costs. FLUSHFLO filters are also noted for their large capacities relative to size.

Data: Capacities and mesh dimensions fully tabulated in Auto-Klean literature. Quotations on request for processes and capacities not already covered.

Typical Applications: Large scale oil and water cooling circuits; hydraulics; washing plants; water treatment plants; machine lubrication, etc.



AUTO-KLEAN MICOM (3)

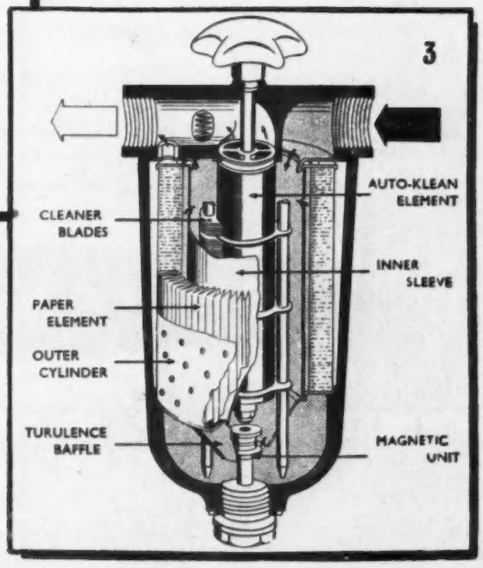
The MICOM combines the advantages of paper as a clarifier with the efficient characteristics of an Auto-Klean, self-cleaning, plate-type element in a full flow filter.

Principle: The greater part of the fluid passes through the plate-type element, while the remainder is filtered by the paper. *The whole of the filtered liquid passes to the outlet side of filter,* thereby giving the maximum protection to the system. A magnetic unit is also incorporated as additional protection against micronic ferrous particles.

Advantages: Positive filtration is guaranteed despite build-up on paper element; paper cannot collapse through choking and therefore its lifetime is increased; constant pressure is maintained as build-up on paper increases . . . while the plate-type filter can be automatically cleaned by turn of the handle—without dismantling. Also important is the low pressure loss and small, lightweight construction of the MICOM.

Data: Working pressures up to 50 lb./sq.in. Can be supplied with ratchet gear for link drive from moving mechanism.

Typical Applications: Ideal for diesel engine lubrication systems of the medium horse-power range and other similar recirculatory applications.



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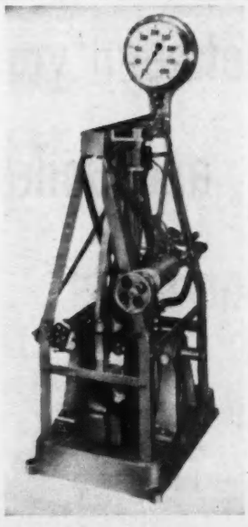

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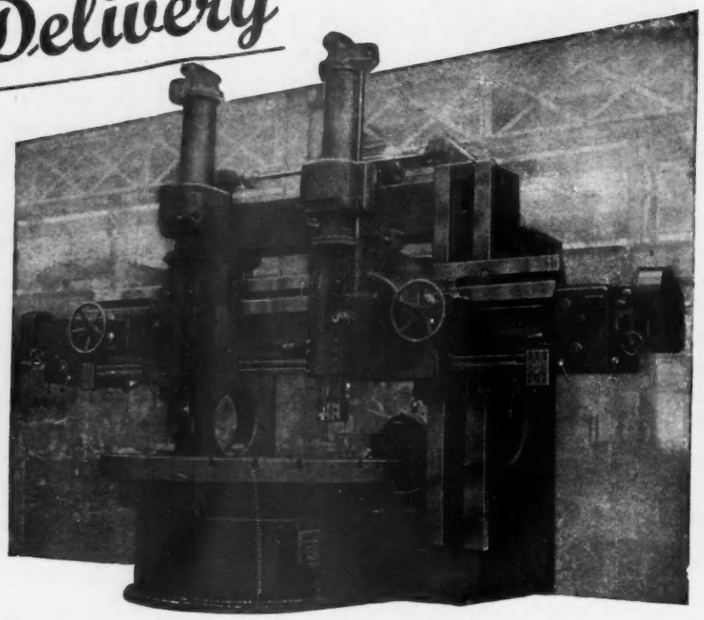

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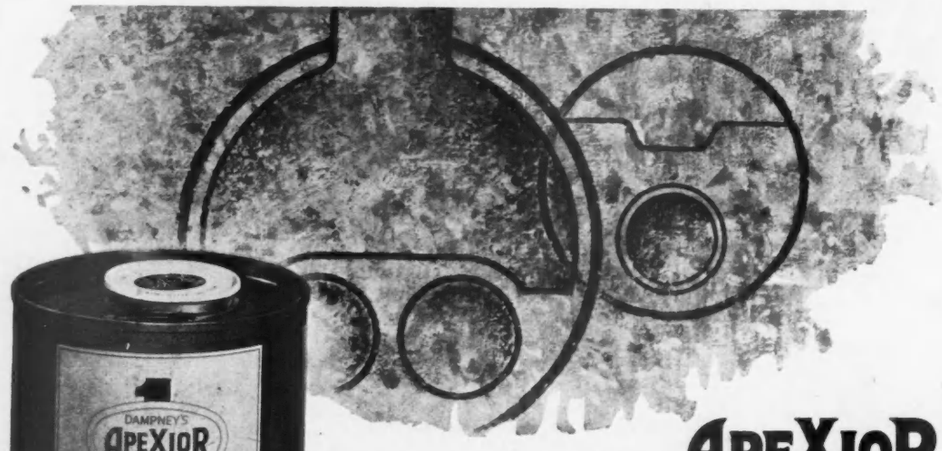

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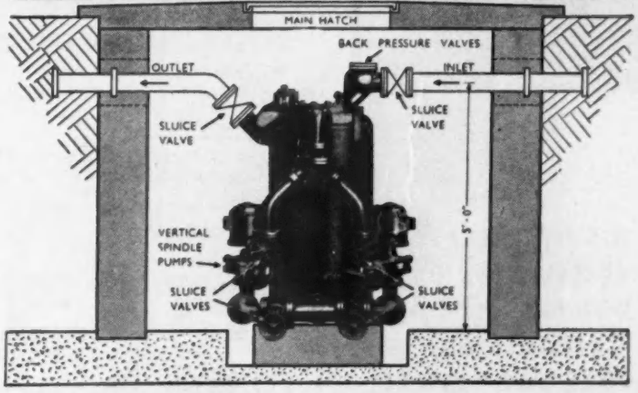

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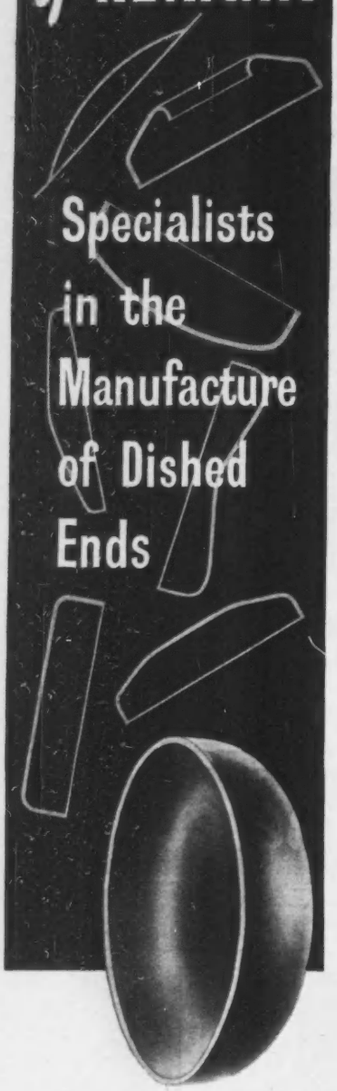

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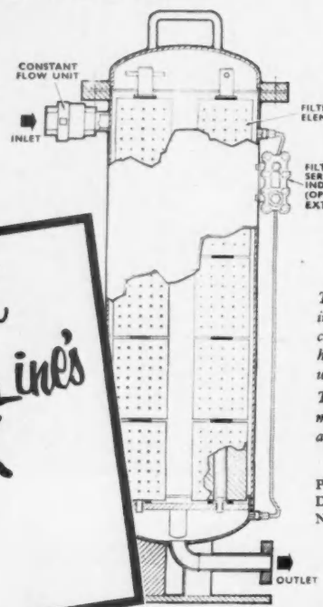

The Micro-Pak is available in a range of capacities, with centre-bolt or multi-bolt head, and either heated or unheated.

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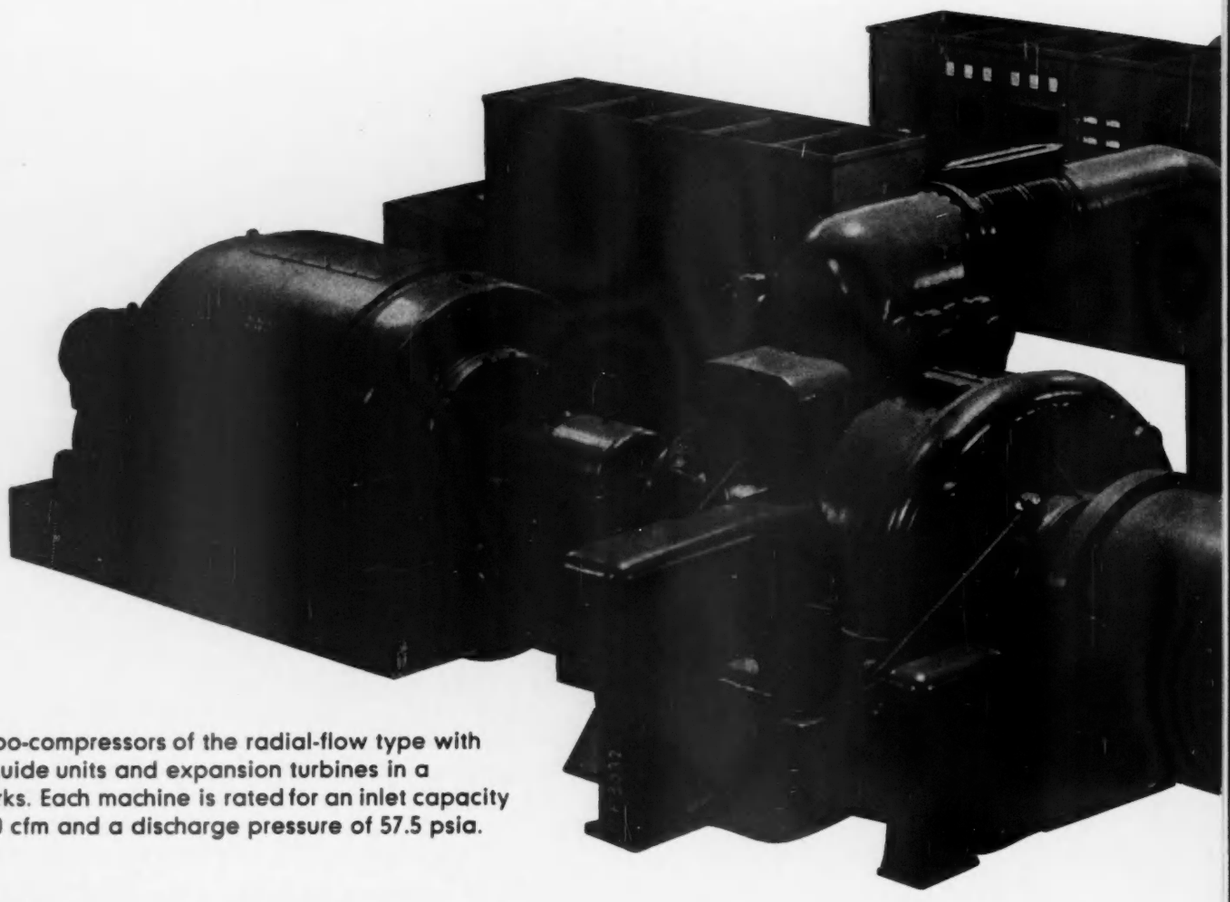

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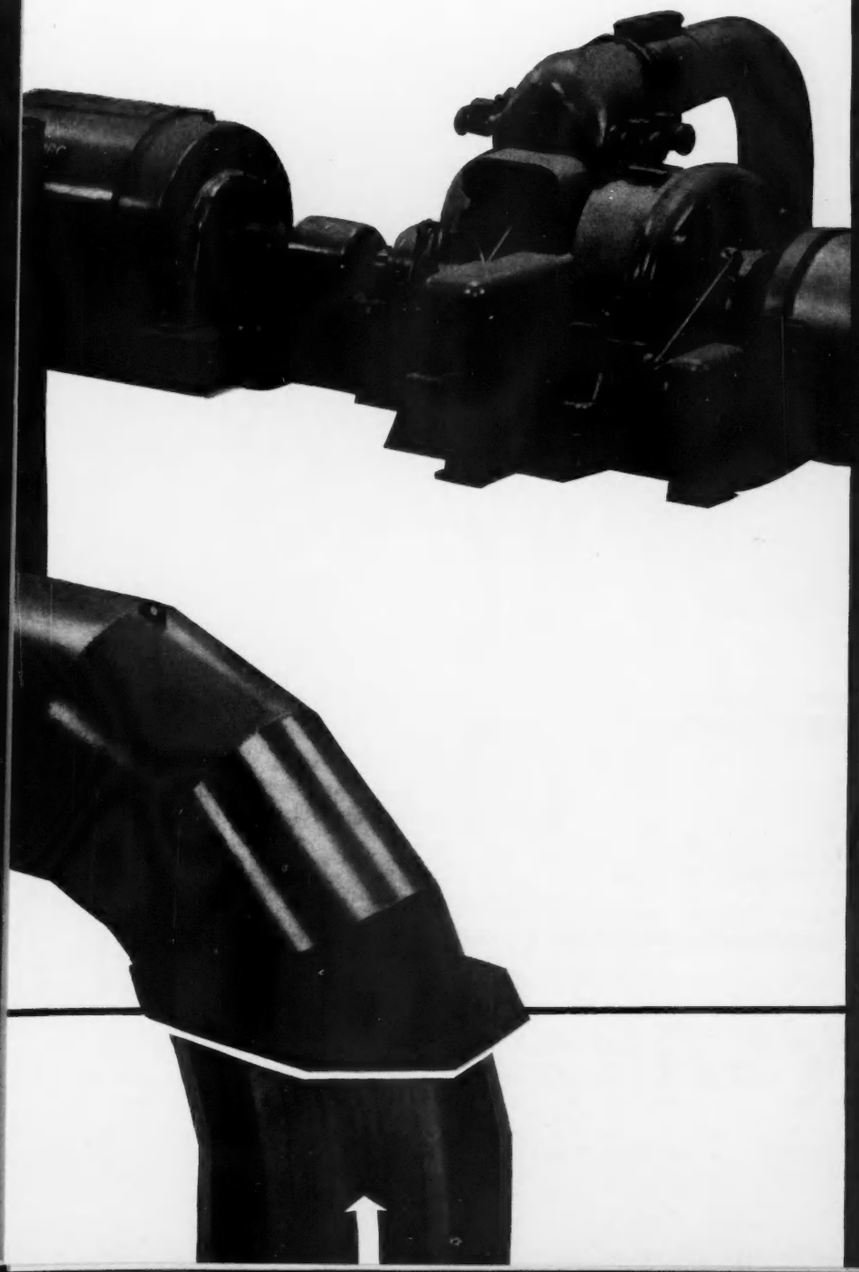

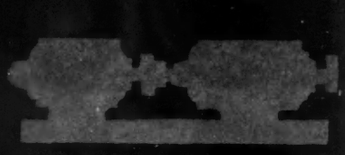

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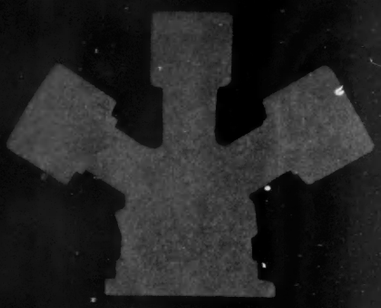

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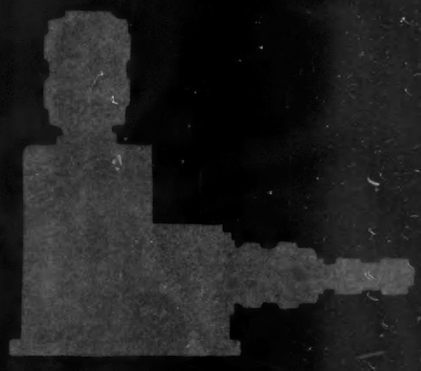

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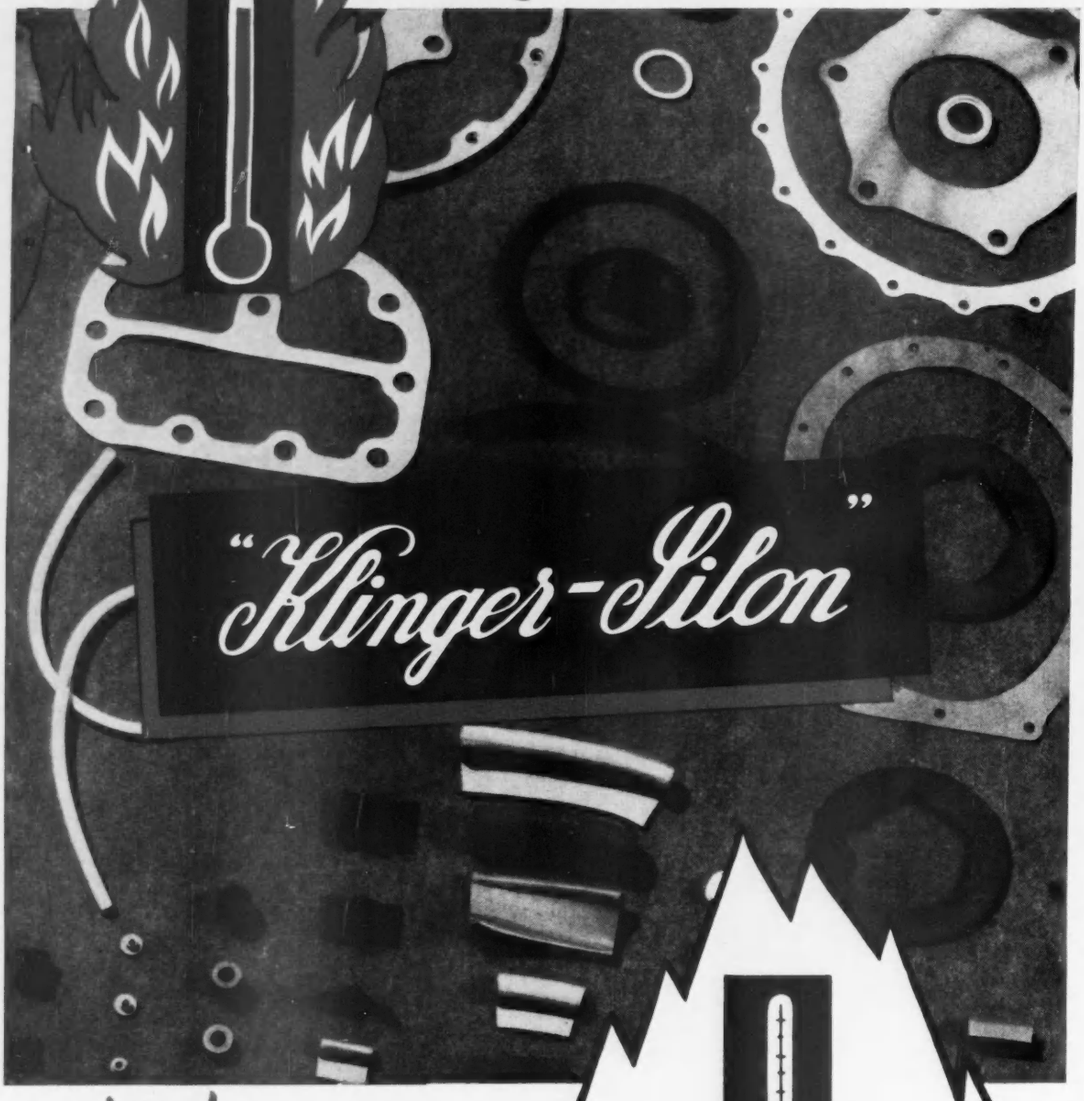

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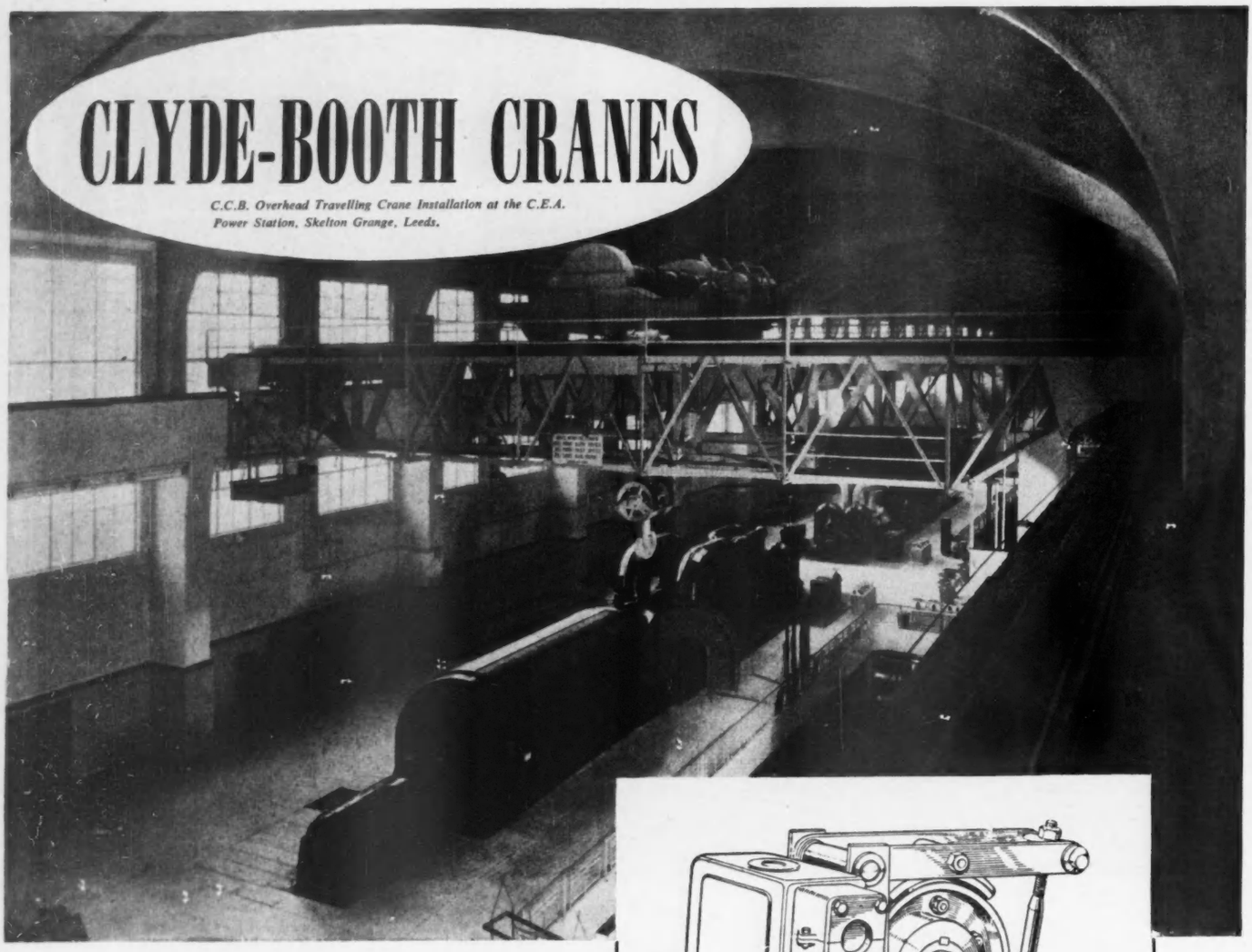

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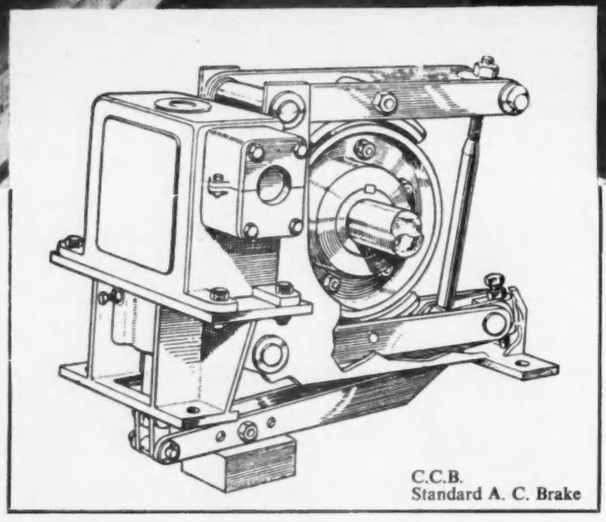

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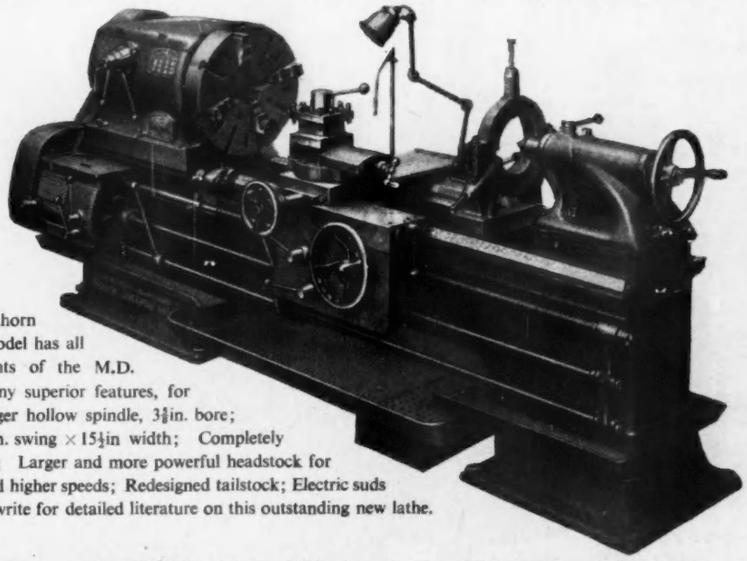

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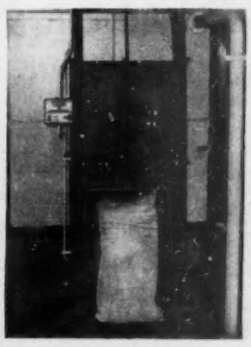

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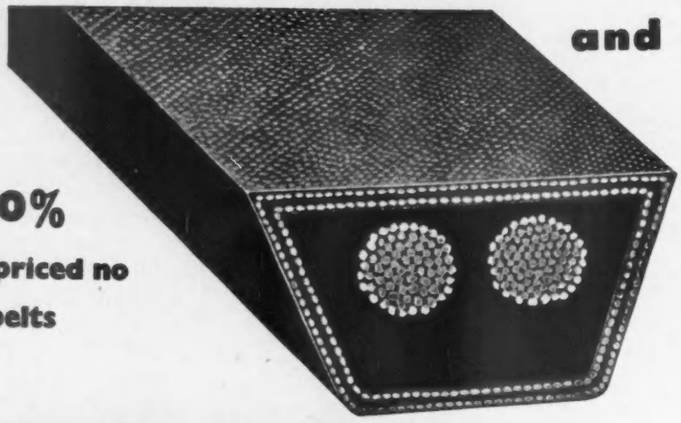

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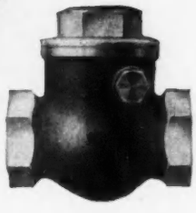
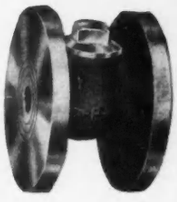


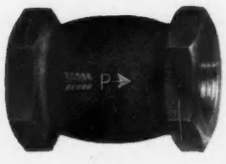
1060A HORIZONTAL or VERTICAL CHECK VALVE

Swinging type. Sizes ¼"-2" — Female ends tapped BSPT (taper) BS21 2½"-3" — Female ends tapped BSPT (par) BS84.



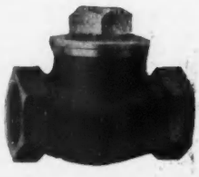
1043 FLANGED HORIZONTAL CHECK VALVE

Lifting type. Prong-type metal valves. Sizes ¼"-2". Flanged to BST 'E' as standard or BST 'F' on request.



1060 VERTICAL CHECK VALVE

Sizes ¼"-2" — Female ends tapped BSPT (taper) BS21. 2½" and 3" Female ends tapped BSPT (par) BS84.



1039 HORIZONTAL CHECK VALVE

Lifting type. Prong-type metal valve. Sizes ¼"-2" —Female ends tapped BSPT (taper) BS21. 2½"-4" — Female ends tapped BSPT (par) BS84.

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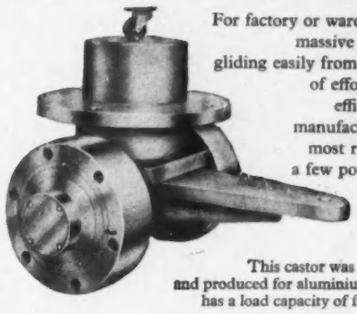

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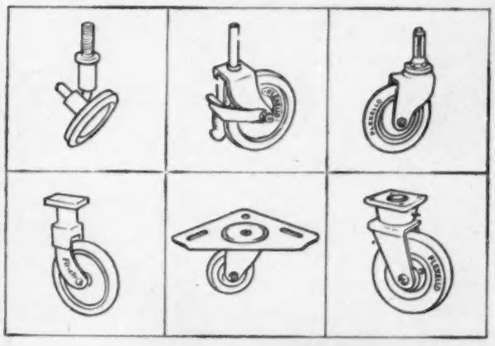

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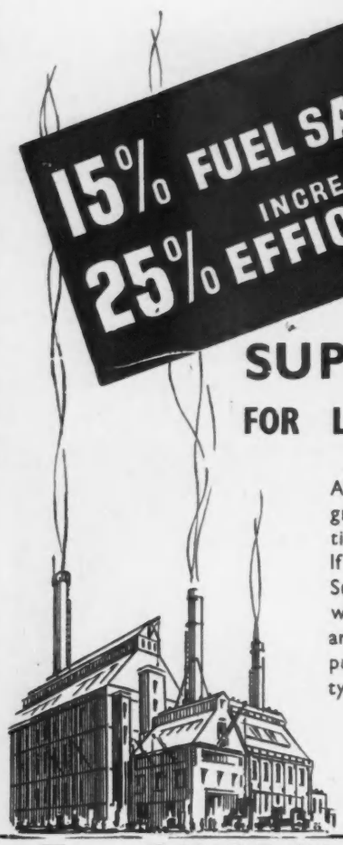

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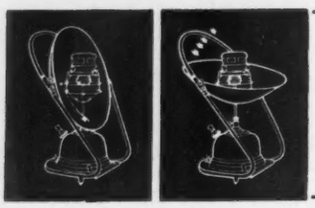

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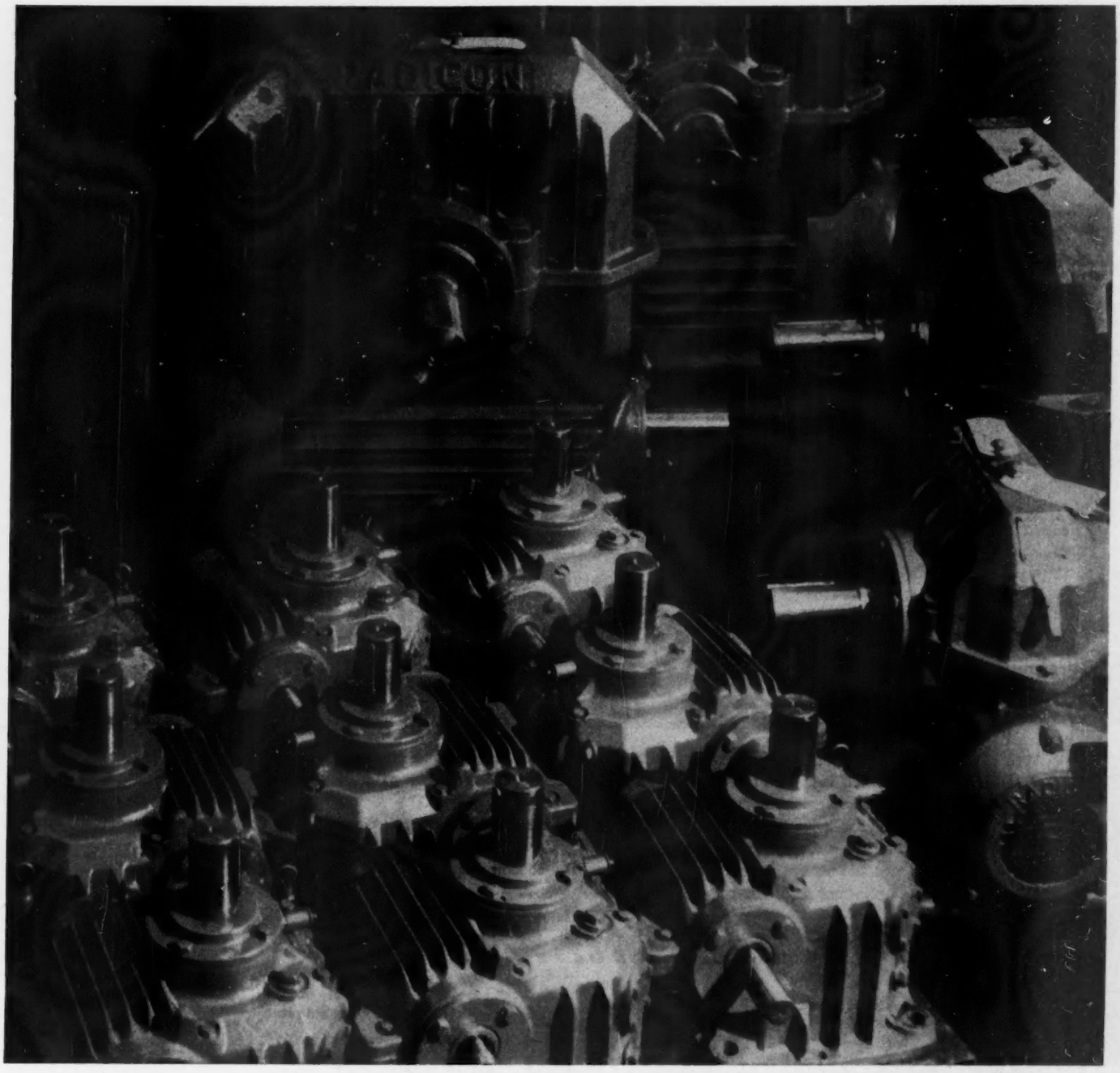

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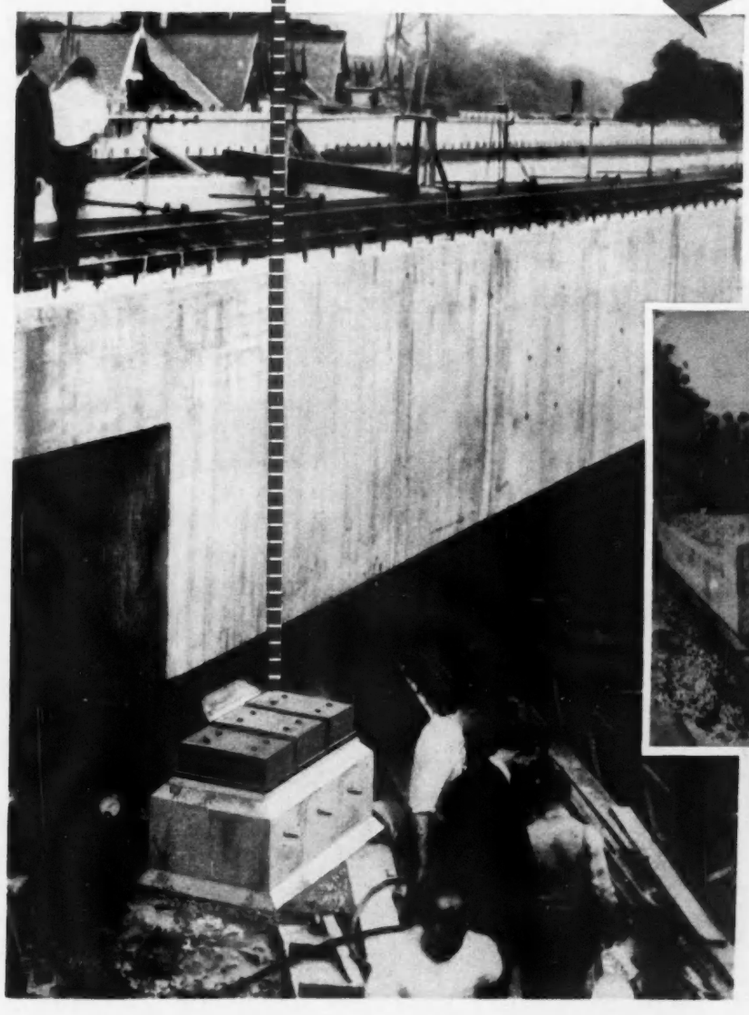

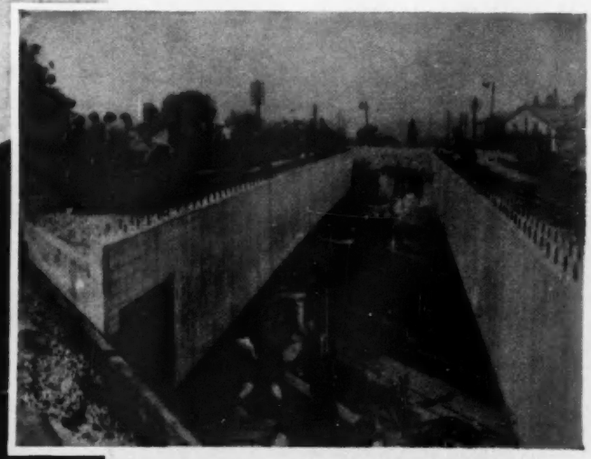

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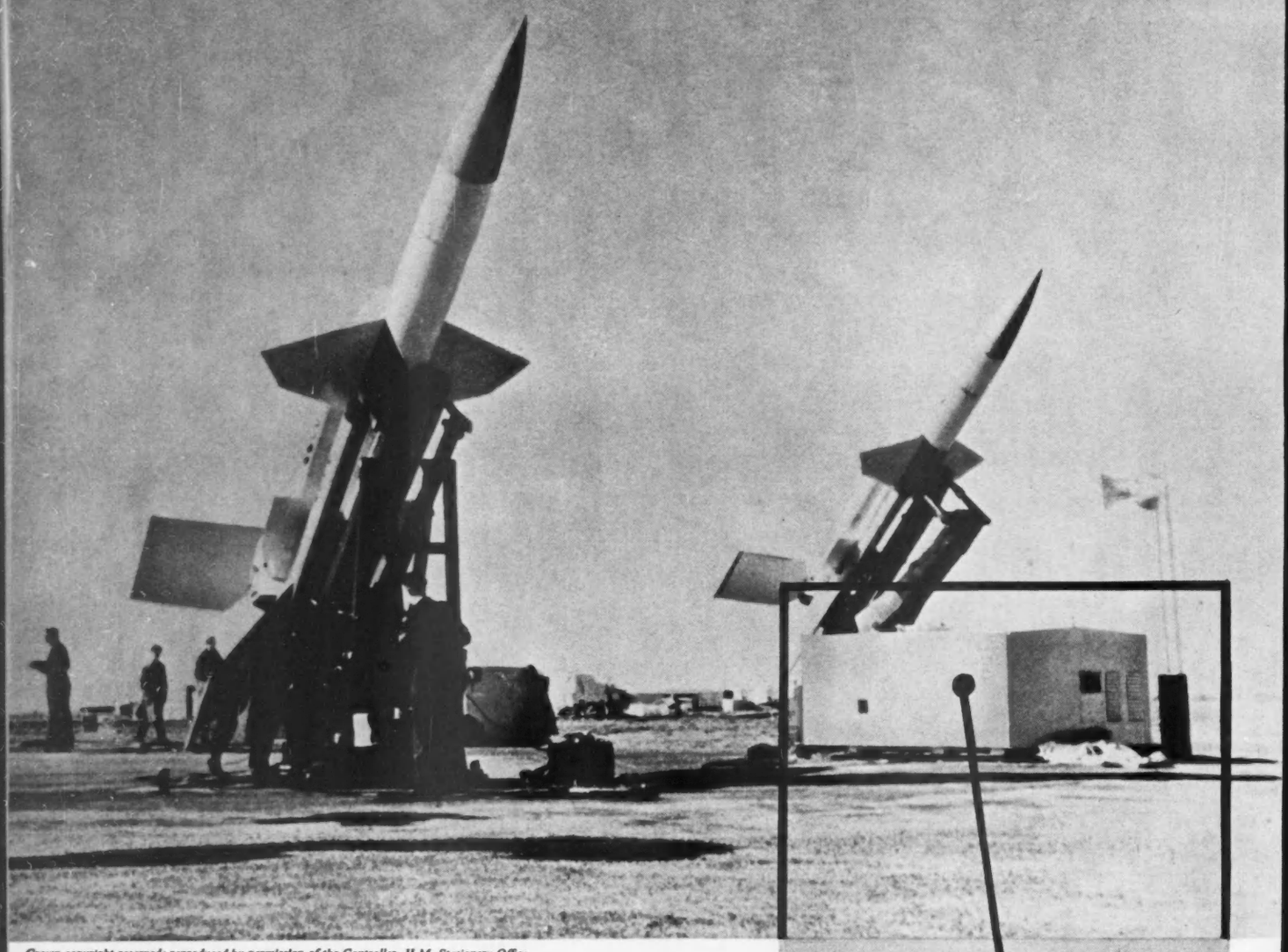

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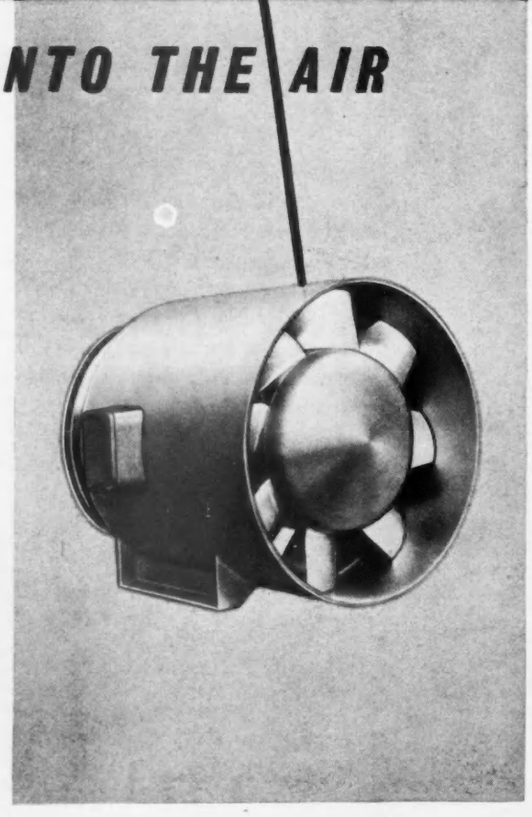

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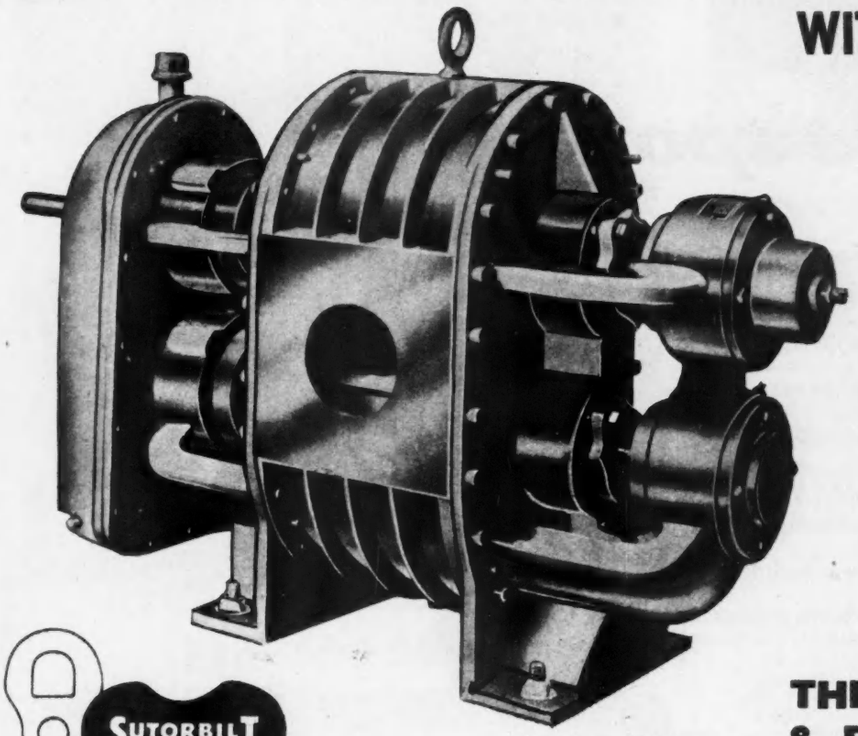

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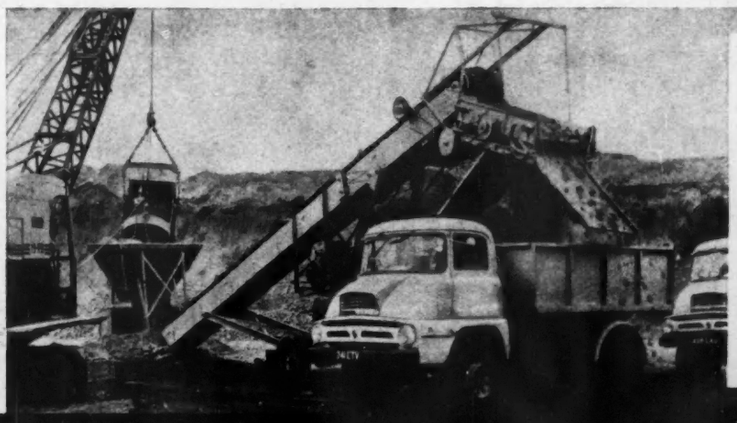

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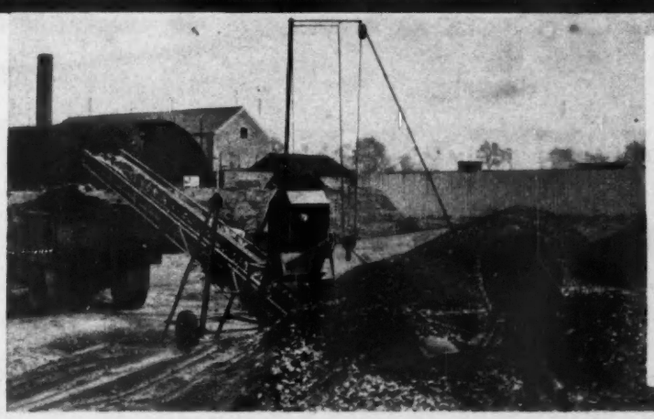

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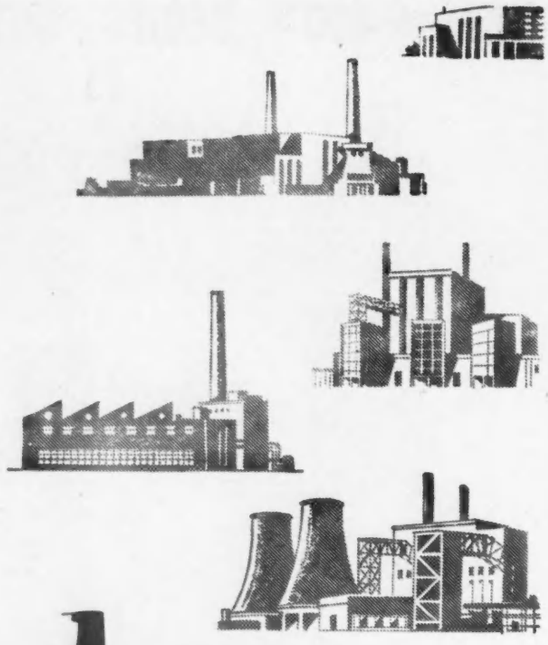

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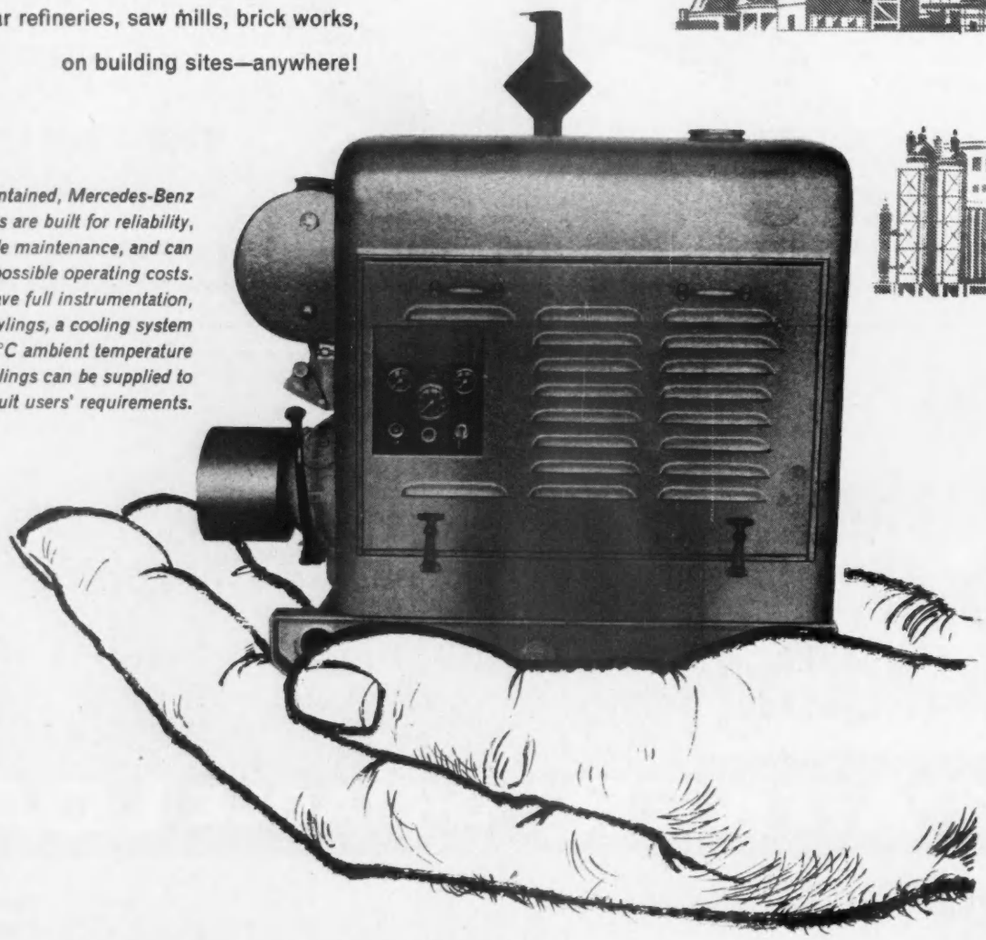

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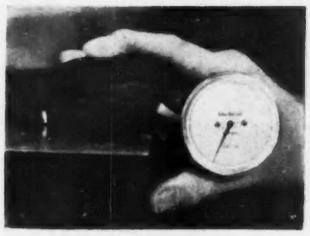
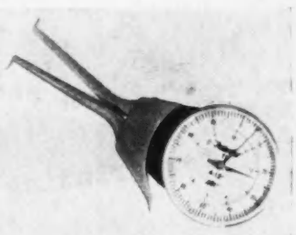

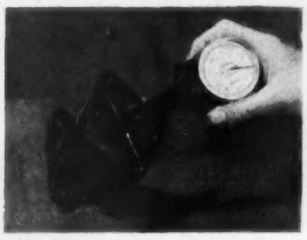

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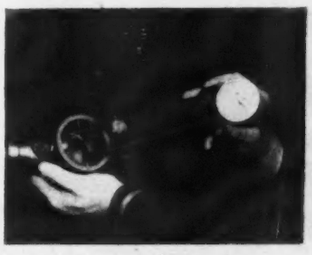
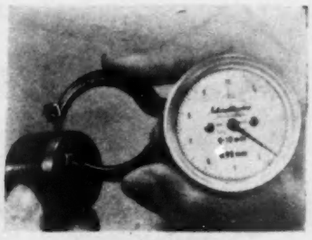

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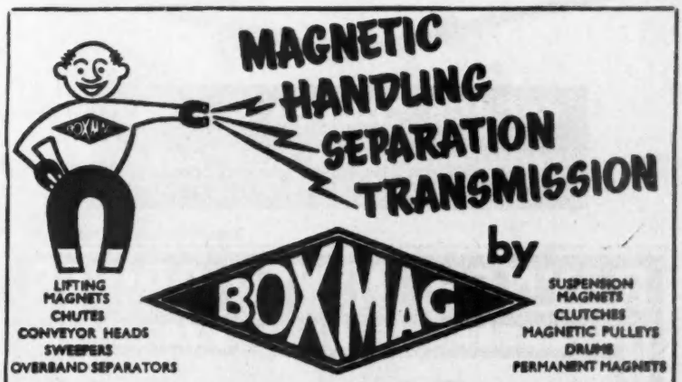

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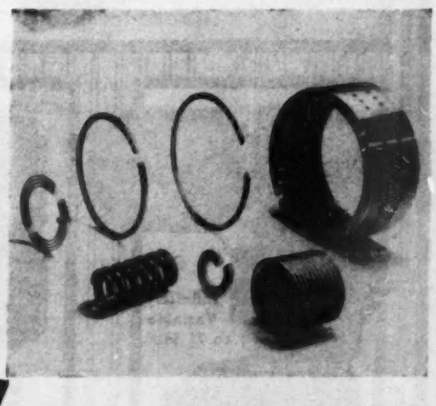

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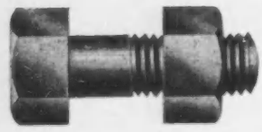

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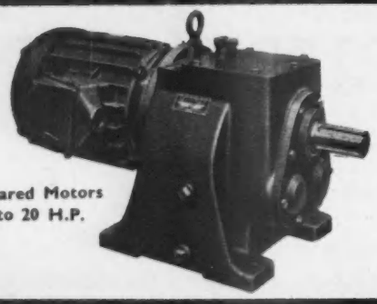

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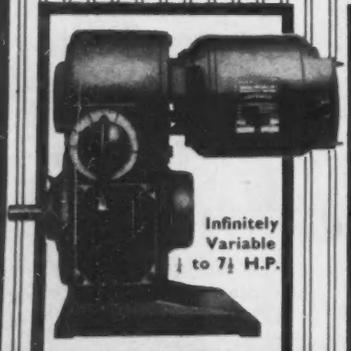

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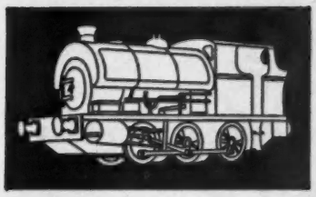

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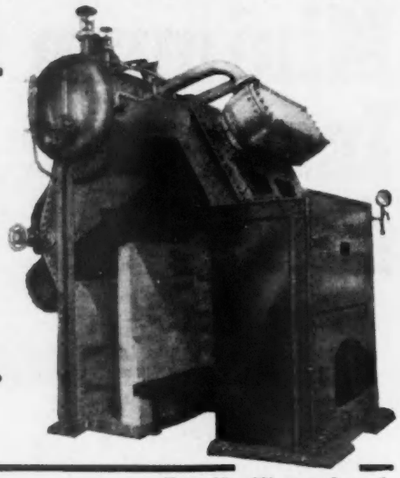

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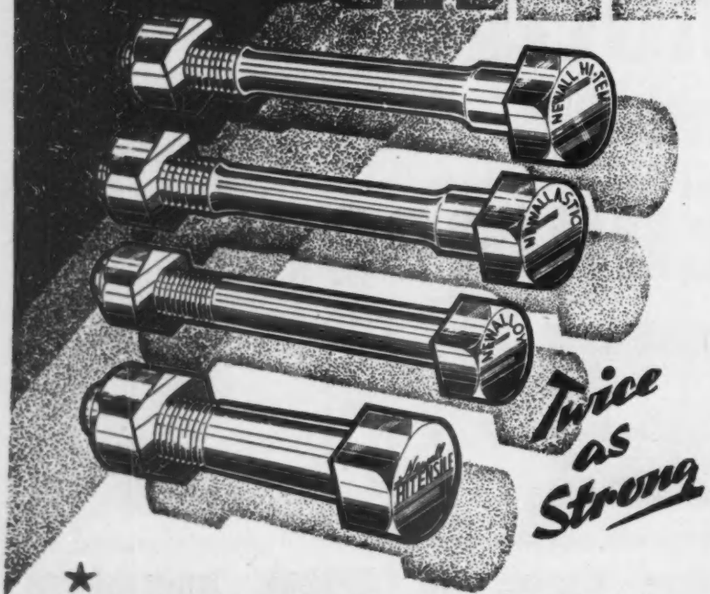

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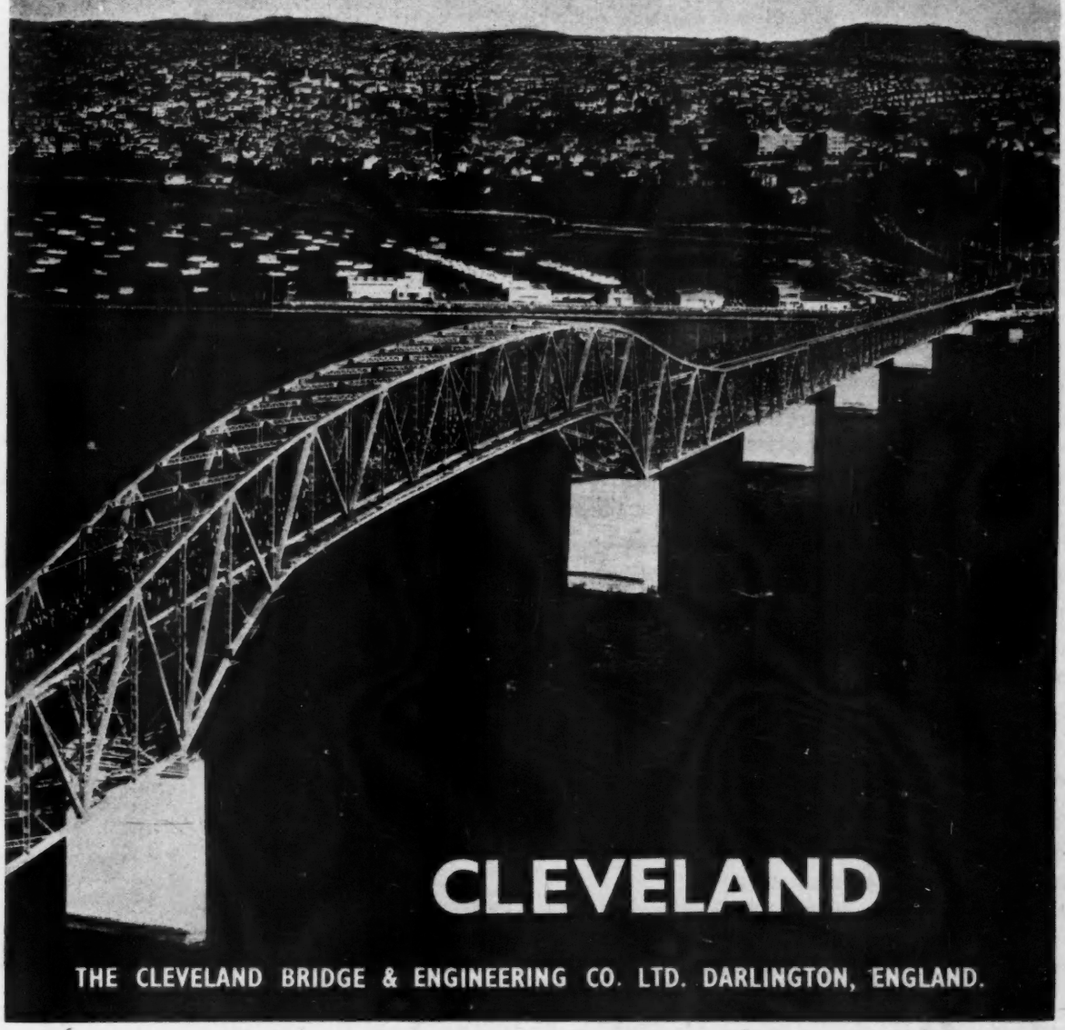

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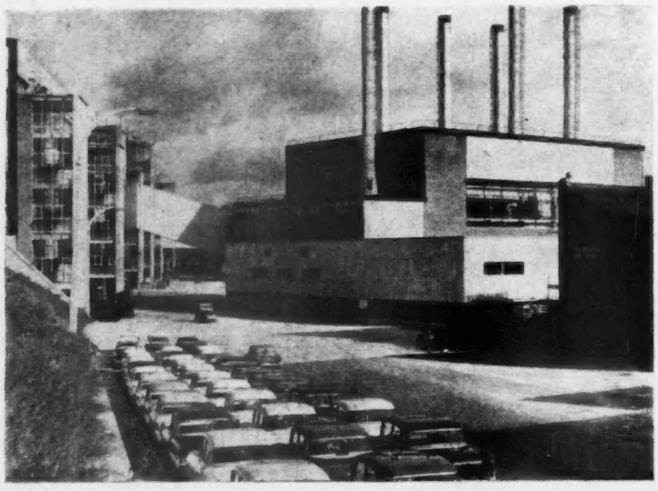

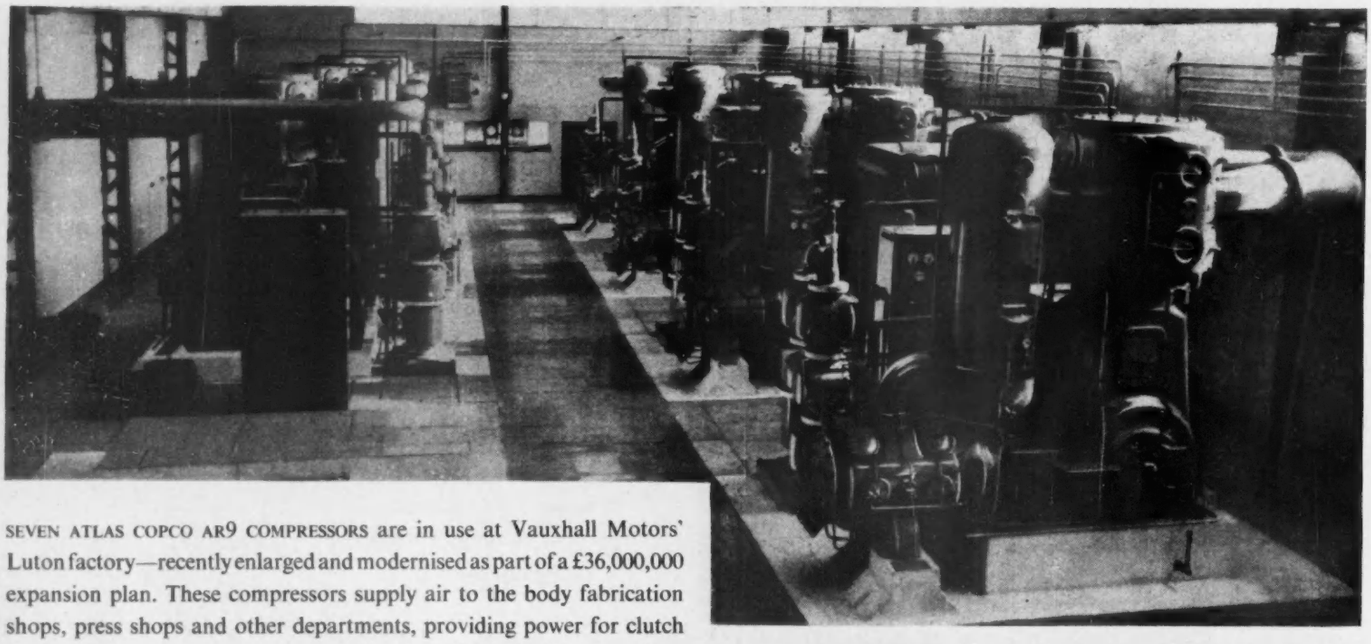

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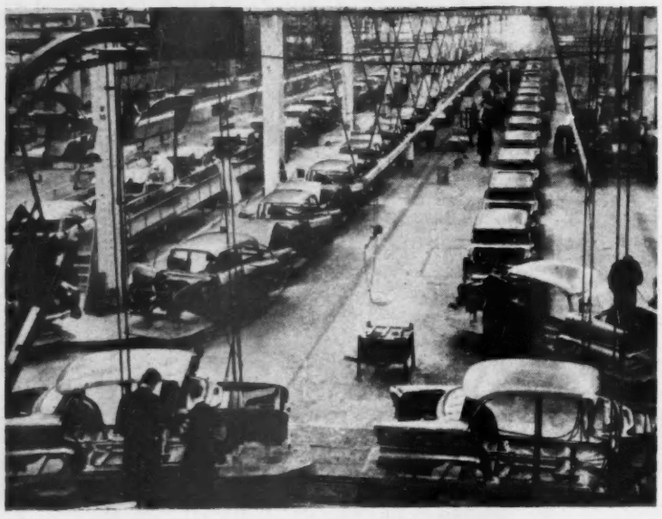

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THE ENGINEER

No. 5425 JANUARY 15, 1960 VOL. 209

AVIATION MERGERS

This week, the Royal Aeronautical Society, in celebrating the ninety-fourth anniversary of the founding of The Aeronautical Society of Great Britain, recalled that this is the golden jubilee of the " Golden Year " of British aviation. The anniversary luncheon on Wednesday was attended by a number of members who were active in that " Golden Year " such as Brigadier-General Sir H. Osborne Mance, Dr. A. P. Thurston, Lord Brabazon of Tara, and Sir Thomas Sopwith. Nevertheless, the guests were preoccupied with the future rather than the past, for the almost legendary ability of the aircraft industry to respond to rapidly changing demands is very generally believed to have been overtaxed by the apparently exponential rate of progress in aircraft design. The day's news included that of a major grouping in the industry of Vickers-Armstrongs (Aircraft), Ltd., English Electric Aviation, Ltd., and Bristol Aircraft, Ltd., the last-named the aircraft building subsidiary of a company which, founded fifty years ago all but a month, grew to be this country's only integrated aeroplane/aero-engine manufacturer. Bristol Siddeley Engines, Ltd., is already owned as to 50 per cent by the Hawker Siddeley Group. As plans have already been made known for a merger of the de Havilland and Blackburn groups with the Hawker Siddeley Group, and as the directors of Westland Aircraft and Bristol Aeroplane Company are reported to have reached agreement for the sale of Bristol's helicopter activities to Westland, thus tending towards a consolidation of helicopter construction, a picture is revealed of the consolidation of British aircraft design and production into a small number of groups. This rationalisation, it is clearly hoped, will give the groups the power to bring to bear really strong design teams and to provide more adequate financial backing and so fit them to meet international competition in a future less full of orders for military aircraft than the past. Whether the hopes raised are fully justified is, of course, another matter. For to judge by historical experience in other industries, rationalisation instead of acting as a spur can sometimes lead to comparative stagnation. However, three firms to which the country has looked without disappointment in the past for major advances in technology, Fairey Aviation, proprietors of the " Rotodyne," Handley Page, protagonists of aerodynes such as the H.P.113, and Short Brothers and Harland, stand fast at present against amalgamation.

What of the immediate future ? This was described by the president of the Society as " The Riddle of the Sandys," since the policy of the Rt. Hon. Duncan Sandys, which may be expected to be significant to the industry, is not yet fully disclosed. (Mr. Masefield disclosed that at least some parts of the industry had desired to see a Ministry of Aviation, doubtless assuming that such an organism would, in order to perpetuate itself, encourage aviation !) It already seems clear that in important details the Ministry of Aviation has rejected certain policies of the erstwhile Ministry of Supply : large firms, for example, such as we see forming to-day, would have been hopelessly handicapped in competition with normal firms in dealing with a customer which favoured charging overheads equally on contracts large and small. There can, however, be little doubt that the Government does favour the consolidation which is taking place.

PROMOTING LOCOMOTIVE EXPORTS

An important activity arising out of the British Railways Electrification Conference next October will be the inspection by delegates from overseas of works where traction equipment is in production. These visits are to be arranged by the British Electrical and Allied Manufacturers' Association, and the Locomotive and Allied Manufacturers' Association of Great Britain. The British Transport Commission has expressed the hope that they will further interest in the traction industry to the advantage of its export trade. Since the conference does not take place for nine months, it is encouraging to know in the present highly competitive situation that an immediate step to assist exports has been taken by the release of a colour film, " British Locomotives," produced by the Central Office of Information with the co-operation of the B.T.C. and L.A.M.A. This, as we have seen from a preview, is of excellent pictorial quality, and the arrangements for showing versions in nine languages in seventy-five countries to widely assorted audiences will spread its message on an appropriate scale. It is, however, a message in non-technical terms, and if the interest in British achievement which it stimulates is to be maintained, it will need to be supported by regular and detailed information on what the manufacturers and the railways are doing. This applies in particular to the new field of electric traction at 50 c/s, in which Continental manufacturers have long been active in publishing particulars of their work, both individually and in collaboration with their home railways. The British Railways Electrification Conference will improve the situation here, but it is a long way ahead and will only realise its true value if it is supported by greater activity than has been apparent hitherto in the timely preparation of reports and literature which prospective customers will find worth keeping by them for technical reference.

Some new problems which the locomotive industry has to face were mentioned in a paper read last month to the Railway Students' Association of the London School of Economics by Mr. G. T. Owen, chairman of L.A.M.A. He remarked that railways in rapidly expanding countries with vast requirements for locomotives are no longer British-owned or controlled and for this and other reasons can no longer be relied on to order British equipment automatically. There is also an increasing trend in countries such as Australia and India (which have long been important export markets) towards indigenous production. In addition, the industry also has to face the activities of finance agencies such as the American Export-Import Bank in the way of long-term loans to

under-developed countries, which have seriously affected exports, particularly in such markets as Argentina and Brazil. Against these difficulties, Mr. Owen set the new advantage of a home market and demonstration ground for diesel and electric locomotives. Furthermore, as recorded in our October 30 issue, a United Kingdom Railway Advisory Service has been established for making available experience gained by the British Transport Commission, in the course of its modernisation plan, to railways in Asia and the Far East. This step has been warmly welcomed by the locomotive industry as evidence of official co-operation in its export drive.

SOME PROBLEMS OF LEISURE

Judging by a long-term trend, there seems to be very little doubt that within a relatively few years the standard working week in engineering factories in this country will have come down to forty hours ; and, if Lord Chandos was right in a speech he made early last month, by the end of this century all our needs will be met by a working force of 24,000,000 people in a sixteen-hour working week ! In these circumstances, the point which has caught most attention is that of the problem of what is to be done with the resultant leisure. There may, indeed, be some justification for fears that it may have bad consequences, for " Satan finds some mischief still for idle hands to do." If so, high wages, short working hours, and general prosperity may be accompanied, deplorably, by more crime than ever ! More probably, in our view, the real difficulty, if hours of work are so very much reduced, will be to prevent people taking on two jobs simultaneously. Even to-day, we suspect that quite a substantial number of men, especially in the building trades, earn extra money on the side.

But there are other points which seem to us of more immediate technical interest. For example, a reduction in hours of work in so diversified an industry as engineering may lead to changes in the relative costs of production of different products. In some works it may prove relatively simple to raise productivity so as to produce as much as before in a shorter time. Moreover, despite much talk to the contrary, it does seem that some of the unions pressing for shorter hours genuinely expect actual hours worked to fall without a reduction of output and are not really seeking to increase earnings through an extension of overtime working. But in other works, where it is the machine rather than the man which determines the speed of working, output may be expected to fall unless more overtime is worked; and thus costs may rise. One way of overcoming such a disadvantage is mentioned in the January *Bulletin* of the British Employers' Confederation. The way to doing so lies through a reduction of wasted time. For undoubtedly there is a good deal of wasted time in factories. Moreover, it strikes us as probable that the amount of wasted time is a function of the hours worked. Under the old sixty-hour week (which a few men still living can possibly remember to have worked) it just was not possible to be strenuously active all day. By modern standards, the work was carried on in a very leisurely way. There has, in fact, been a substantial reduction of wasted time as hours of work have been reduced ; and it consequently is reasonable to assume that it should be possible to reduce it still further. However, there are, no doubt, certain industries in which the effect of shorter hours of work cannot be offset against any immediate increase of productivity or reduced wastage of time. In those industries the answer to increases of wage rates or reductions in hours worked must remain what it has always been—the expenditure of capital upon plant which will permit employees to do more in a limited time.

There is one further thought on this subject which has occurred to us and which has also been expressed in a recent letter to the *Times*. The Western nations are at last beginning to recognise that they have a moral responsibility to aid the under-developed countries. It may possibly seem to those countries that by cutting down hours of work and thus, seemingly, reducing output, we are intent to sit back and enjoy our wealth when we ought morally to be devoting some of it to helping them to become more nearly as rich as ourselves. We do not, in fact, think there is any truth in the argument. For, paradoxical as it may seem, the experience of the West has been that reduced hours of work (except in a depression) are invariably accompanied by higher, not lower outputs. The reason, of course, is that the higher the cost per hour of a man's work, the more worth while it becomes to expend capital upon machinery which will multiply his effectiveness. In fact, in relation to the moral need of the West to help the under-developed countries, actual hours worked in Western factories are almost irrelevant. For in that connection it is output which counts and there is no suggestion at all that output would fall. But under-developed nations may take a deal of convincing about the point !

RAILWAY PRESERVATION

The area of Sussex between the main lines to Brighton and Hastings is threaded by a number of branches, which, in the course of years, have earned such felicitous titles as the " Cuckoo " line, the " Primrose " line and the " Bluebell " line. Train services were provided originally by the London, Brighton and South Coast Railway, stimulated by the knowledge that if it did not do so, the South Eastern might step in and open up the territory with a new main line to Eastbourne. For many years all went as merrily as a May morning in this railway Arcadia, until at length there appeared on its borders a cadaverous maneater soon identified as the British Railways lion in search of an appetiser for the larger meals it had in mind. Its choice fell upon the unhappy " Bluebell " line, and there then began a conflict as dramatic in its details and as dire in its inevitable outcome as that in old Provence between Monsieur Seguin's goat and the wolf, but lacking a Daudet to record it. The lack is being made good, however, for the writing of a history of the line is one of the tasks undertaken by the Bluebell Railway Preservation Society.

At present the society is negotiating for a lease of the $4\frac{1}{2}$ miles of track from its headquarters at Sheffield Park station to the junction with the Southern Electric at Horsted Keynes. Later it is hoped that it may be possible to acquire a " Terrier " tank engine in working order and some old L. and S.W.R. coaches which used to run in a staff special between Brighton and Lancing carriage works, but have recently been withdrawn. There is already an indoor museum at Sheffield Park, and acquisitions in the shape of locomotives and rolling stock could form the nucleus of an outdoor display of working exhibits which could be drawn on as required for running trips between there and Horsted Keynes. Scrap metal prices for locomotives are high, and it is thought that a more practicable means of securing them would be some form of leasing arrangement for types nearing the end of their days but still serviceable. There are many such which may not be of sufficient technical significance to warrant preservation on railway premises, but which it is sad to see disappear. The society just missed a Stroudley " D " tank which had been disposed

of by a private purchaser, but is keeping an eye on the last days of classes such as the Drummond "T9" and the surviving Adams and Beatty tanks in the West Country. Meanwhile Sheffield Park station has been restored, entirely by voluntary labour, to the colour and smartness of the old Brighton days and is hopefully awaiting the arrival of its next train. Whatever success the society achieves, its members (now more than 500) will know that it has come through their own enthusiasm and efforts, and that their work may kindle in others similar interests which would not respond so readily to the more formal atmosphere of a conventional museum.

INDUSTRY IN RURAL AREAS

A paper on the effect of industrial development in rural areas was read at a meeting of the Royal Institution of Chartered Surveyors last week, the author being Mr. Colin Clark, the director of the Agricultural Economics Research Institute at Oxford University. The distribution of industry is a topical subject which is exercising many minds and we are interested to note that, in his paper, Mr. Clark emphasises that "the sharp, economic and topographical demarcation between town and countryside was a nineteenth century phenomenon and destined to be comparatively short-lived." That is a fact which is not always fully appreciated by the hardened townsman! We agree with Mr. Clark when he says that "motor transport is making the industrialisation of the countryside quite possible," though we do not support him as fully when he questions whether the incursion of industry into the countryside is desirable. Nevertheless, Mr. Clark is willing to predict that industrialisation in the future, relying upon road transport, will be spread out over fairly wide zones. Under these conditions, however, he feels that "remote districts"—defined as those over 100 miles distant from the principal industrial centres—will probably continue to deteriorate economically.

Mr. Clark's paper goes on to point out that the road transport age, which is following the railway age, has set manufacturers and traders free from the close confines of industrial cities within which they had previously been held. Furthermore, he says, road transport is "setting the people free, too," for "homes no longer have to be cramped within a narrow circle around the industrial centre." But, in the final sentences of his paper, Mr. Clark advances the somewhat gloomy thought that transport may have done its work all too well. "If we go on the way we are now going," he observes, "the final result will be an ugly and planless dispersal of population spreading almost uniformly over a whole industrial zone, perhaps in England an almost continuous built-up area from Liverpool to Dover, with most of the rest of the country impoverished and depopulated." This rather dismal prognostication could, of course, turn out to be accurate. But we hope not; and one contributor to the discussion following Mr. Clark's interesting paper dispersed our momentary gloom! He declared that he could not take a pessimistic view about encouraging industry to move to rural areas, for he believed that it stimulated the satisfactory development of those areas. Engineers, we think, will support that view. Progressive mechanisation is surely pointing the way to the fuller integration of agriculture and industry.

TRAFFIC ENGINEERING IN LONDON

The development of traffic engineering in London will be the subject at the next meeting of the Civils' Traffic Engineering Study Group on January 21; and we notice that a paper prepared by Mr. A. J. H. Clayton, as a starting point for the discussion, stops short at 1938, leaving plenty more to be said during the evening—we trust. Since this is still the formative stage of modern traffic engineering in this country, these discussions are of more than ordinary importance, and it is to be hoped that they will continue to be well attended, particularly from far afield, even when only metropolitan problems are on the agenda; for one city's traffic is very like another's, and it is from detailed discussions such as these that principles emerge.

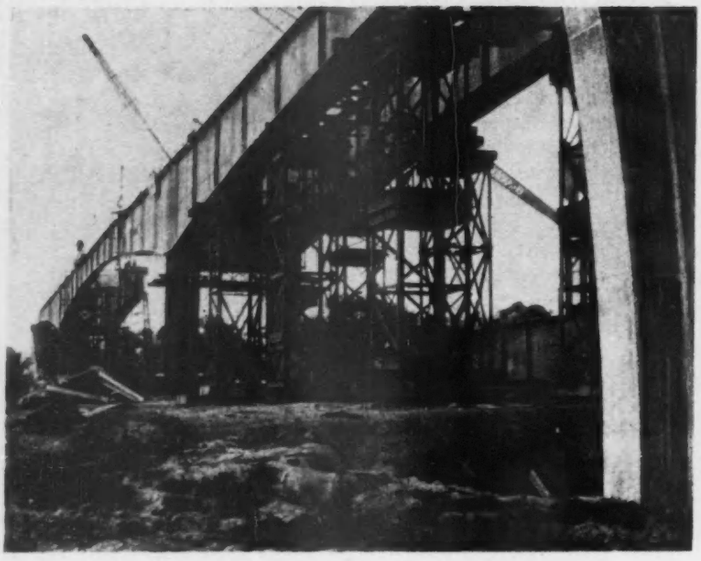
We contribute just one reflection, arising from Mr. Clayton's revelation that "eleven different schemes were worked out on paper for Trafalgar Square before the system still in use was put into operation in 1926." Creditable though that may be, our reflection is that during the weeks and months needed for working out those schemes, Trafalgar Square must have continued in costly confusion. To perfect the solution on paper first was a typically civil engineering approach to the problem: the civil engineer builds to last and cannot afford mistakes. But it occurs to us that the traffic engineer can afford to experiment. His direction signs and lane lines and control lights can often be altered overnight to rectify or improve upon what has gone before. Moreover, an attempt to achieve perfection often turns out to be a form of procrastination! Experimentation and anticipation of changing traffic needs may lead more surely, even if somewhat adventurously, towards perfection in traffic engineering. It is a lively art. Mr. Henry A. Barnes, Traffic Director of Baltimore, U.S.A., was able to say after four years of that sort of adventurous traffic engineering: "I guess we know 2000 things that won't work"; and by then he had made his city an outstanding example of what can be achieved by the lively art.

The Engineer—100 Years Ago (JANUARY 13, 1860)

"ENGINEERING ASSOCIATIONS"

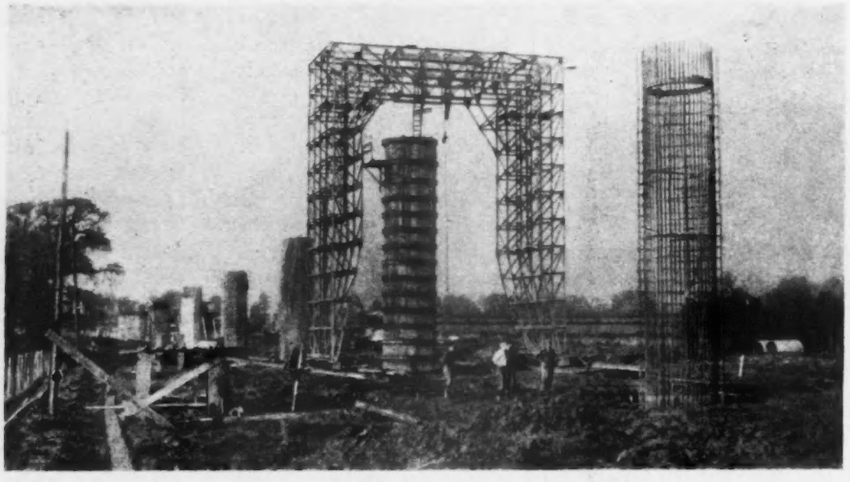
"Our readers cannot fail to have observed an increasing tendency among the junior members of the profession, towards the formation of independent associations of engineers. We are disposed to attach some significance to this movement, and we certainly regard it with much satisfaction. The present influential Institution in Great George-street was a very small affair in the beginning, although its founders had actually executed works which would now make the reputations of any equal number of engineers. Half a dozen members at a meeting was a large attendance, and these were quite conscious that they possessed no importance in public estimation. Engineering was not then looked upon as anything more than a craft, and beyond friendship for each other, and a regard for their calling, engineers had no inducement to associate themselves together. The Institution of Mechanical Engineers was established under better auspices, but it has necessarily more of a commercial and less of a professional character than that which distinguishes the organisation in Great George-street . . . .

"It is at this time that the young men, who are to be the successors of our leading engineers, appear disposed to unite themselves together, to compare and to develop their opinions, free from the restraint which they confess they would feel in the presence of the older members of the profession. It is plain that we are to have more competition of talent, and that the domain of privilege, influence, and exclusive reputation, is to be invaded on all sides. Our opinion, in this respect, is drawn from the increasing strictness with which the test of commercial success is now applied to engineering . . . . Commercial knowledge is becoming more and more essential to engineering success."

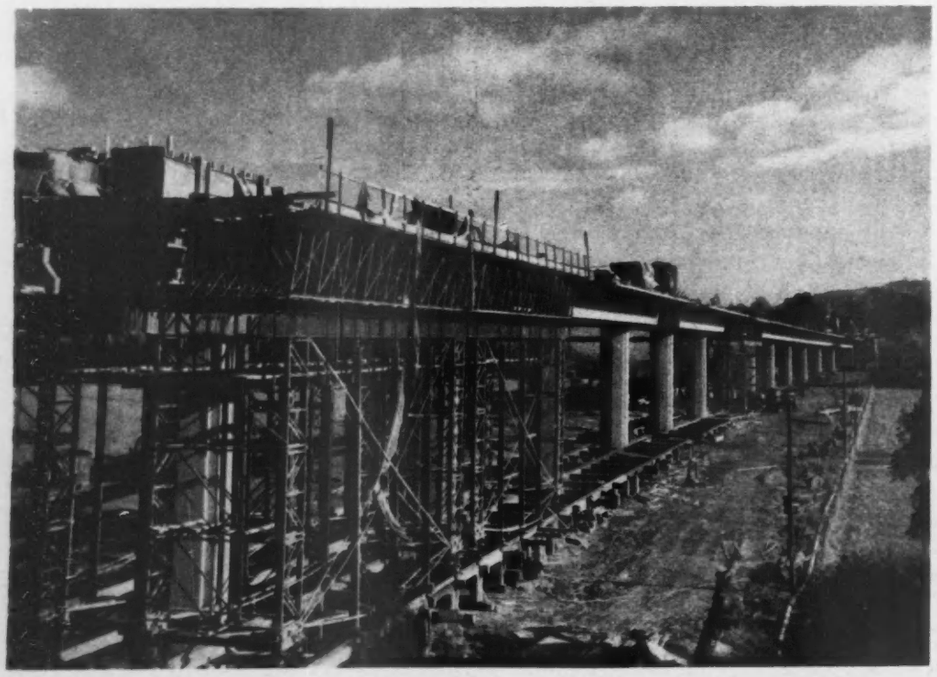


Ross Spur Motorway

Queenhill Bridge over the River Severn; Above, LEFT, steel erection, RIGHT, steelwork at an "anchor pier." RIGHT, Column shuttering and gantry for the approach spans, and, BELOW, approach spans with the large rail-mounted shutter in the foreground. The total length of the bridge is 2466ft, the central span of 237ft 6in, and flanking spans each of 131ft 3in, being in riveted structural steelwork. On each side of the steel structure is a span of 84ft 8in in r.c., and then fourteen 81ft 8in r.c. spans, and eight similar spans respectively. Dual 24ft carriageways are on separate structures. Consultants, Sir Alexander Gibb and Partners; contractor, A. E. Farr, Ltd. See "The Engineer," October 23 last.



Queenhill Bridge is a principal structure of the Ross Spur motorway, for this section of which the Ministry of Transport's agent is Mr. W. R. Thomson, M.I.C.E., the county surveyor of Worcestershire. The motorway is 20 miles long, and in Gloucester and Hereford is the responsibility of the respective county surveyors, Mr. R. A. Downs, A.M.I.C.E., and Mr. D. H. Banks, M.I.C.E. Consultants for bridges are W. S. Atkins and Partners, and Scott and Wilson, Kirkpatrick and Partners; R. M. Douglas (Contractors), Ltd., and Tarmac Civil Engineering, Ltd., are also contractors.



In Gloucestershire, the road has gravel and stone foundations and a coated stone surfacing. Last winter the construction of precast, prestressed concrete sections and of bridge foundation and culvert works was in progress. The bulk earthworks were, in general, completed last summer. By autumn all bridges except one were completed and drainage and road foundation works had commenced. Two road bridges and one farm access bridge are now open to traffic and work is proceeding on approach roads to three bridges and on approximately one-third of the contract which is on a sand and sandstone formation. The remainder is on red marl on which site traffic is difficult during bad weather. Details of the Worcestershire section of the road were given in "The Engineer" of December 26, 1958.

Motorway Construction in 1959

THE national road programme began to take shape in 1959, and its first results were apparent. It became increasingly evident, however, that the planned rate of Government expenditure on roads was inadequate, and public clamour for better roads increased. In particular, urban road problems—hitherto largely neglected—were thrust into the public eye. In fact, most of the controversies and publicity accompanying the work of civil engineers during 1959 centred around roads, in one way or another, and it is now clear to all that, over the next decade or so, road building will be the major task which the community will call on the civil engineering profession to direct and sustain.

This brief review is confined principally to motorway schemes under construction in 1959. The first length of motorway in the country—the Preston by-pass, which is only about 8 miles in length—was completed just before the year started. The major event of the year was the opening of the M1 route between London and Birmingham in November, involving about 75 miles of motorway. This has already been adequately described and illustrated, and we showed a typical " interchange " on M1 in Plate 1 last week. Two further motorways under construction in Lancashire were also described and illustrated on Plate 2. One of these schemes, the Lancaster by-pass, will eventually link with the Preston by-pass to form the north-south motorway route, M6. Further south, the construction of three major viaducts on the M6 route, Thelwall and Gathurst viaducts in Lancashire and Cresswell viaduct in Staffordshire, was started during the year. Another major motorway scheme, the Ross Spur, is exemplified by the illustration of the Queenhill Bridge, and details of progress in the Gloucestershire section given on page 84.

Apart from the schemes already mentioned, three major schemes were in progress during 1959, namely, the Doncaster by-pass, the Maidenhead by-pass, and the Maidstone by-pass. The Doncaster by-pass is due for completion in 1961. Part of it is being built under the direction of the Nottinghamshire county surveyor, Mr. R. A. Kidd, by Sir Robert McAlpine and Sons, Ltd., but the major section of the road is in the West Riding, and is under the direction of the county surveyor, Mr. S. Maynard Lovell, the contractor being the consortium Cubitts-Fitzpatrick-Shand. This by-pass is the largest of a series of schemes scattered along the A1 route like a gigantic darning operation on an old sock 300 or so miles long. Another large scheme in this series, costing over a £1,000,000, the Catterick by-pass in the North Riding, was completed last month.

In the West Riding, the County Council acting as agents for the Ministry of Transport, has prepared a large programme of schemes for the improvement of A1 to modern dual carriageways standards. The estimated total cost of this programme is approximately £12,000,000, extending over 52 miles, and involves the construction of eight major by-passes and six diversions, linked by sections of the existing route improved to the new standards. The Doncaster by-pass motorway is the largest of these schemes. It will be 12½ miles long with twelve overbridges, eleven underbridges, three footbridges, one subway and four major culverts. The length on fill is 6 miles and the balance of 6½ miles in cut with 5 miles of the route on rock. Contract works commenced last June.

Excavation and haulage of magnesian limestone was in progress with R.B.38, 54 and 110 face shovels and " Euclid " dump trucks. A large amount of blasting has been necessary in the harder limestone, but in the softer limestone and where hydraulic rooters are able to be used, the material is push loaded into D.W.21 box scrapers, which are also being used for the excavation of the marl which usually overlies the limestone, and for the soft Bunter sandstone which occurs. Face shovels are excavating a ¾-mile section through boulder clay, but here 8 cubic yard lorries are being used to haul the material by road to the place of deposit in embankments. At the southern end, peat was encountered for about 1 mile to a depth of 6ft. This was removed during the summer using Lima 1201 draglines, the excavation being back filled at the same time with imported material using lorries. The whole of the earth-moving operations are expected to be completed by the early spring.

Maidstone by-pass. Construction of bridge carrying motorway over railway at Allington

Bridge over the River Wharfe on the Wetherby by-pass. This particular road is not a motorway, but is one of a series of improvements to dual carriageway standards, which include one stretch of motorway

The bridge crossing the Don Valley at a height of 70ft above the river is the most important structural feature. This is a seven-span viaduct, 750ft long, carried on concrete columns with a steel superstructure; 4ft 6in diameter concrete cylinder piles 40ft long distribute the load to the underlying rock.

Underbridges are single-span structures with prestressed pretensioned decks up to about 50ft span and post-tensioned decks in the spans ranging from 50ft to 80ft. The abutments are reinforced concrete counterforts. Overbridges generally have four spans with prestressed pretensioned beam decks supported on reinforced concrete piers and either mass concrete bank seats or reinforced concrete skeleton abutments. About half of the bridges are now under construction, including the five bridges over or under railways, and delivery of precast deck beams to the site is due to commence. The works will cost nearly £5,000,000.

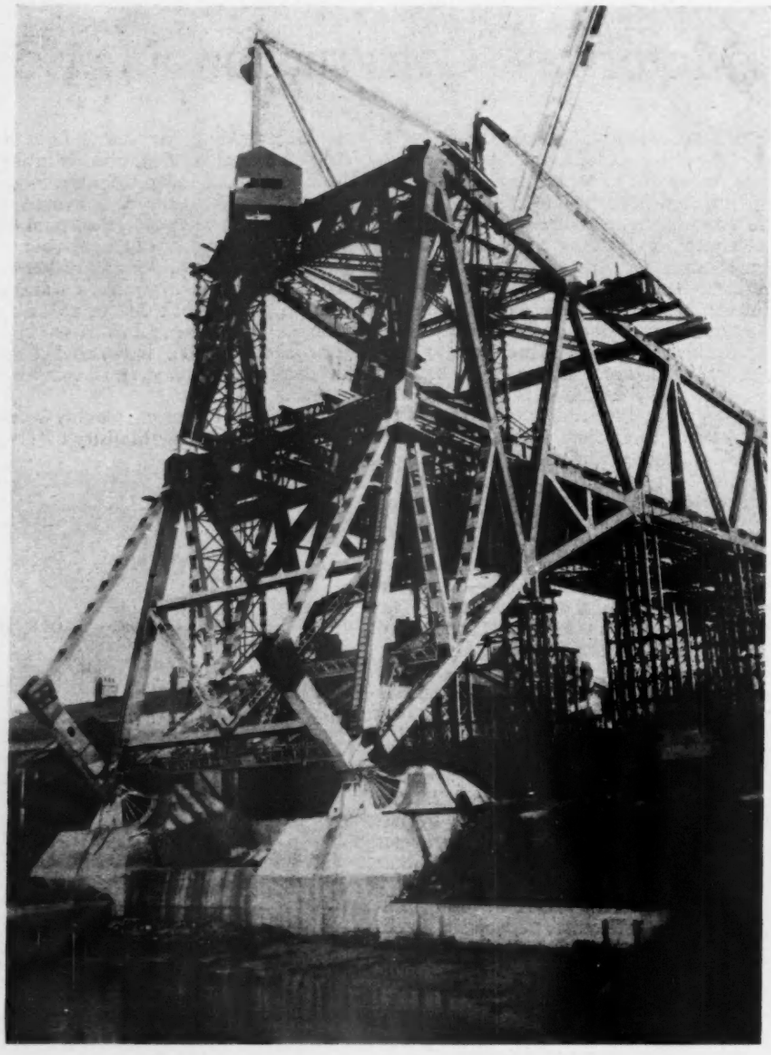
From the northern end of the motorway

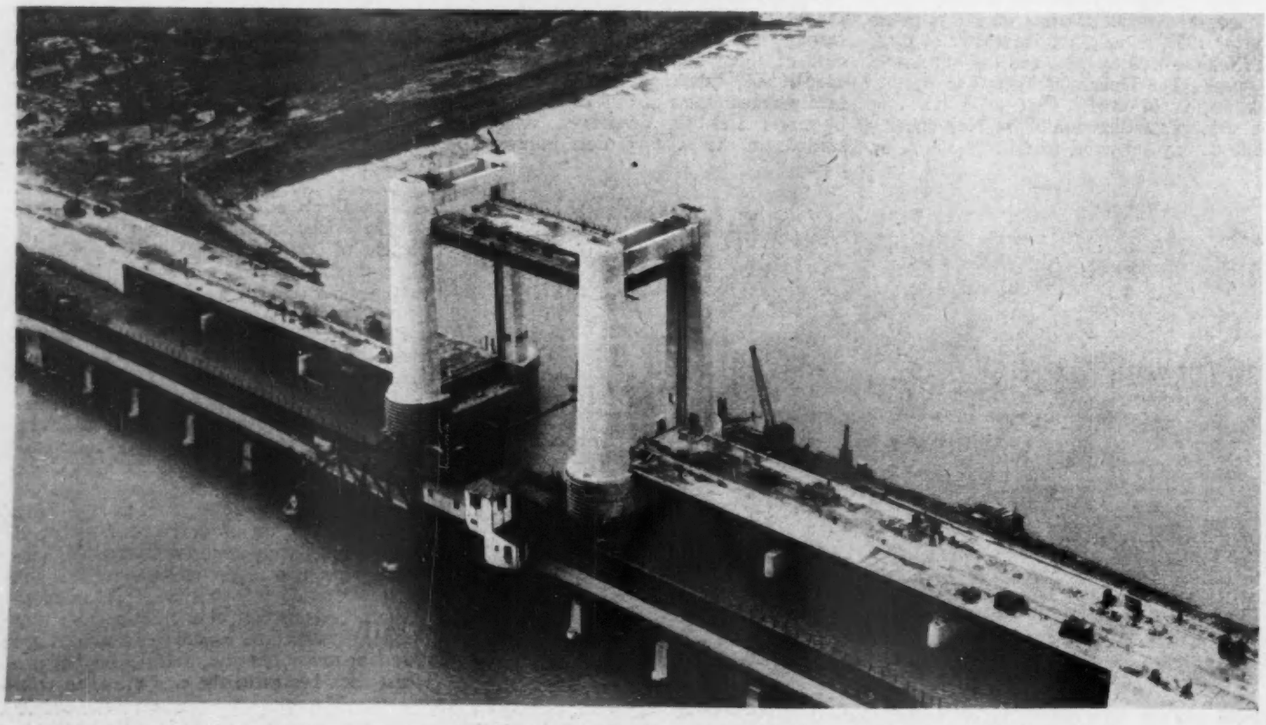
Bridges

Recent progress in erecting the steelwork of the Runcorn–Widnes bridge is shown on the RIGHT. The main arch will span 1082ft, with a continuous side span of 275ft on each side, all in trussed steelwork, with high-tensile steel for the main members of the arch ; the height of the arch will be 253ft. The illustration shows the western skewback with temporary erection trestles in position under the side span, and a crane partly erected on top of the permanent steelwork, for erection of the main arch. Certain of the principal members, positioned where corrosion is thought to be most severe, are being metal sprayed. Approach viaducts with spans of 70ft to 90ft, will have lengths of 1425ft and 780ft respectively on the Runcorn and Widnes banks. The steelwork contractor is Dorman Long (Bridge and Engineering), Ltd.

The first lifting bridge to be built in this country since the war was almost completed at the end of 1959. It gives road and rail access across the river Swale, between the Isle of Sheppey and the Kent mainland, and carries two lanes of road traffic and a single line railway. The vertical-lift span gives a clear opening 90ft wide and 95ft high at high water. An interesting point is the construction of the towers in concrete, which gives the bridge an unusually clean appearance for this type of structure, as may be seen by comparison with the lifting bridges on the St. Lawrence Seaway described in our issue of June 19 last. The lifting span is 120ft long ; it will be raised by electric motors to its full height in one and half minutes, when running on the normal main electricity supply. A standby diesel-electric set will be available, however, which will be capable of raising the bridge to its full height in about fifteen minutes. All the bridge machinery will be housed in the piers at each end of the lifting span with a synchronising tie between the motors to ensure that the span remains level during raising and lowering. Operation of the bridge will be from one of the towers. There are three steel approach spans on each side of the lifting span, giving a length of 650ft for the seven steel spans, and the total length of the bridge, with approach embankments, is about 2500ft. The contractor for the bridge is John Howard and Co., Ltd.; sub-contractors are Dorman Long (Bridge and Engineering), Ltd., for the steelwork, and Sir William Arrol and Co., Ltd., for the lifting machinery. The approach roads were built by direct labour by the County Surveyor of Kent.

The consulting engineers for both the bridges depicted on this page are Messrs. Mott, Hay and Anderson.





at the roundabout at Redhouse, A1 will be an all-purpose dual carriageway road on which twenty-two new bridges or widenings are required, including those necessary for the flyover crossings to be built at selected junctions. In general, all bridgeworks will be carried out in prestressed construction using both precast and post-tensioned beams. By-passes are being built to avoid the built-up areas of Wentbridge, Ferrybridge, Brotherton, Micklefield, Aberford and Bramham. Wetherby by-pass was opened to traffic last October, and we illustrate the bridge over the River Wharfe at its southern end.

The five main routes in the previous Minister of Transport's scheme of new roads included the A1 and M1 routes already referred to, and the continuation of the latter northward as M6. The third route was to be from London to South Wales, including the Severn Bridge and the Slough and Maidenhead by-passes, of which construction of the latter started last May. Four miles of motorway is under construction, at a cost of over a £1,000,000. There are to be seven bridges on this length of road, plus a 270ft span steel bridge over the Thames on foundations completed in 1939. The road is due to be completed in December of this year.

The fourth route—from the Midlands to South Wales—has already been exemplified by the Ross Spur motorway, which is to be 22¼ miles long. And the fifth is to give access from London to the Kent Coast and Dover and Folkestone. Here, the Maidstone by-pass was under construction during 1959, and is due to be completed this year. The road is in two sections, and progress of the eastern section was reviewed in our issue of September 4 last, page 182.

The western section was started last April ; it covers 2¼ miles of road and has two interchanges. The motorway will later be continued from Aylesford to bypass Ditton and Larkfield.

There are six bridges on this length, including the main feature of the motorway, the bridge over the River Medway. A Bailey bridge for site access over the river was erected by the Royal Engineers as an exercise. The road is built partly on the Folkestone sands and partly in the Hythe beds (Kentish Ragstone). Altogether there are 600,000 cubic yards of excavation. The construction depth is 16in, comprising 4in sub-base, 8in dry lean concrete and 4in hot rolled asphalt laid in two courses (2½in base and 1½in carpet). Messrs. Scott and Wilson, Kirkpatrick and Partners are the consulting engineers for the bridges at Allington over the river and the railway, the latter being illustrated on the first page of this article.

The Medway bridge provides for future widening of the river and non-interference with river traffic during construction. The construction is of large prestressed concrete box girders supporting a reinforced concrete deck, which is in turn supported on reinforced concrete piers founded on ragstone. The remaining bridges, designed by the Kent County Council, have main beams of precast concrete supported on piers of *in situ* reinforced concrete. Piled foundations are used in the Chatham Road bridge where a fault occurs between the gault clay and Folkestone sand.

The western section of the Maidstone by-pass is being built under the supervision of the County Surveyor of Kent County Council; the contractor is Sir Robert McAlpine and Sons, Ltd.

Shipbuilding and Marine Engineering in 1959

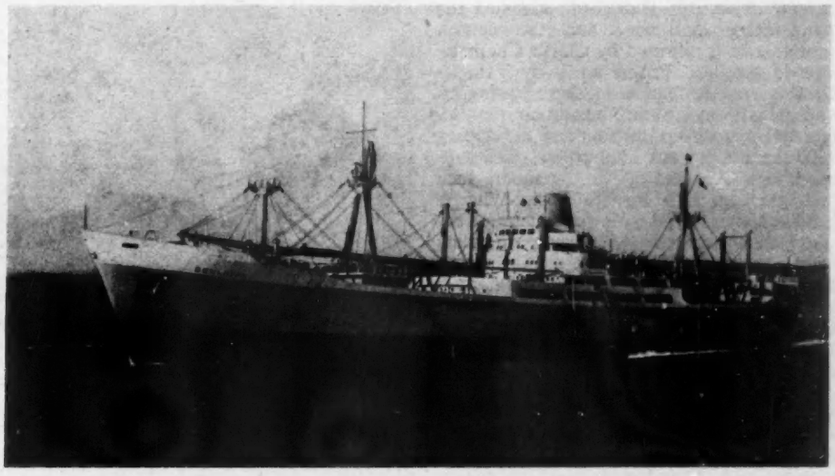
No. III—(*Concluded from page 60, January 8*)

OUR issue of January 1 reviewed the state of shipbuilding and the marine industry generally and in the following issue the progress made in, and the present state of, the research programme of the British Shipbuilding Research Association, and that of Pametrada, were recorded. In this issue we include descriptions of ships of various categories to conclude our annual review of British shipbuilding.

Cargo-Passenger and Cargo Ships

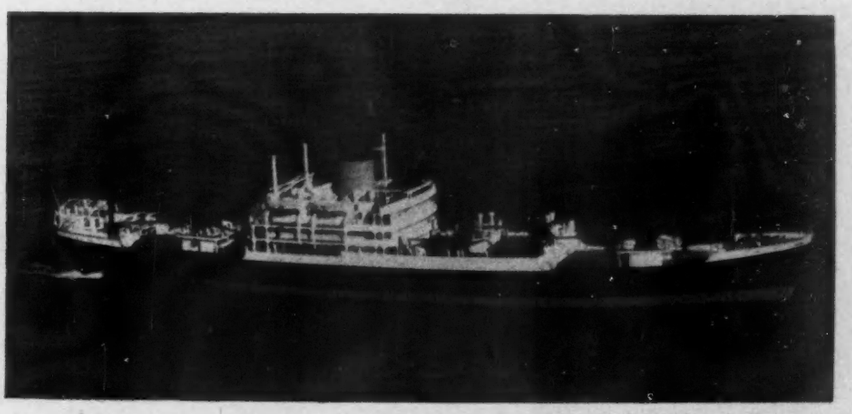
The first of a new class of high-speed cargo liners " Benloyal " was delivered by Charles Connell and Co., Ltd., to Ben Line Steamers, Ltd., and was described in THE ENGINEER of March 13. The ship has a length of 505ft between perpendiculars, a beam of 71ft, a depth of 44ft 6in, a loaded draught of 30ft, a deadweight of 10,962 tons, and is propelled at 19 knots by a set of Rowan-Pametrada double-reduction geared turbines of 14,000 service shaft horsepower at 105 propeller revolutions per minute. Our illustration shows the general appearance of the ship, which has six holds equipped with MacGregor steel hatch covers and served by a derrick complement, which includes one to lift 70 tons and one to lift 50 tons, operated by electric winches. Four 200kW Allen generators, each driven by a Ruston and Hornsby diesel engine, supply electrical power. Steam is provided at 600 lb per square inch and 850 deg. Fah. by two Babcock and Wilcox selectable superheat boilers working under forced and induced draught.

A deadweight of 15,800 tons is carried on 31ft 4in draught by the cargo ship " Duke of Sparta " built for the Trent Maritime Company, Ltd., by the Furness Shipbuilding Company, Ltd. The main dimensions are length between perpendiculars 480ft, breadth 66ft, depth to upper deck 42ft 6in, and cargo from the five main holds is handled by one 30-ton, twelve 5-ton and two 3-ton derricks. Electrical demands are met by three 200kW diesel-driven generators and propulsion is by a five-cylinder Horten-Doxford oil engine having a brake horsepower of 5500 at 115 r.p.m. and burning heavy fuel.



Fast cargo liner " Benloyal " for Ben Line Steamers, Ltd.

The cargo liner " Machaon," illustrated herewith, has a length overall of 495ft, a breadth of 65ft, a depth to upper deck of 36ft, a deadweight of 9800 tons and was built by The Caledon Shipbuilding and



Cargo liner " Machaon " for Alfred Holt and Co.

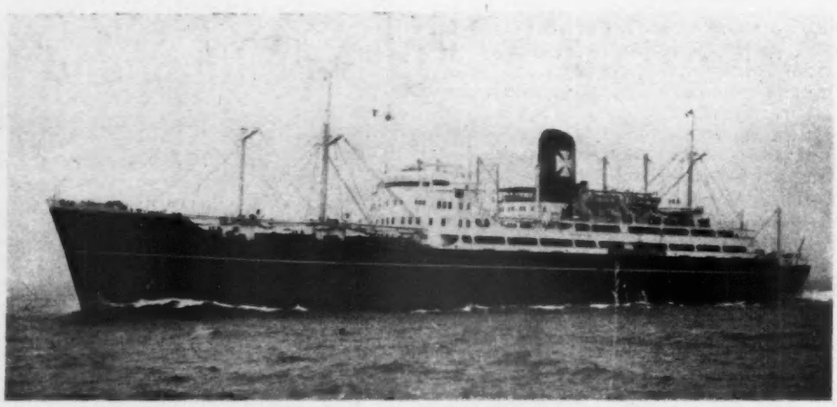
Engineering Company, Ltd., for Alfred Holt and Co. There is accommodation for twelve passengers, the public rooms being equipped with Thermotank air conditioning system. Twenty-seven derricks, including one of 35 tons capacity, handle the cargo from six holds and are operated by twenty-four electric winches. A service speed of 15 knots is maintained by a turbo-pressure-charged opposed piston oil engine, constructed by J. G. Kincaid and Co., Ltd., developing 8500 b.h.p. at 115 r.p.m. The demands for electrical energy are met by three 330kW diesel-driven generators.

The Houlder Line, Ltd., took delivery, from Hawthorn Leslie (Shipbuilders), Ltd., of the "Royston Grange" for the River Plate service of the company. Twelve passengers are accommodated in the ship, which we illustrate, and the whole of the accommodation is air conditioned. There are four holds forward of and two holds aft of the machinery spaces, all of which are insulated and fitted with MacGregor hatch covers. J. and E. Hall, Ltd., supplied the refrigerating machinery and the derrick complement is powered by Clarke Chapman electric winches. Propulsion is by a single-screw geared turbine installation having an impulse pattern h.p. turbine and an impulse-reaction pattern l.p. turbine and developing 8500 maximum shaft horsepower when supplied with steam at 500 lb per square inch and 800 deg. Fah. by two Foster-Wheeler E.S.D. boilers. The main particulars of the ship are length between perpendiculars 460ft, breadth 65ft 6in, depth to shelter deck 35ft 3½in, and service speed 16 knots.

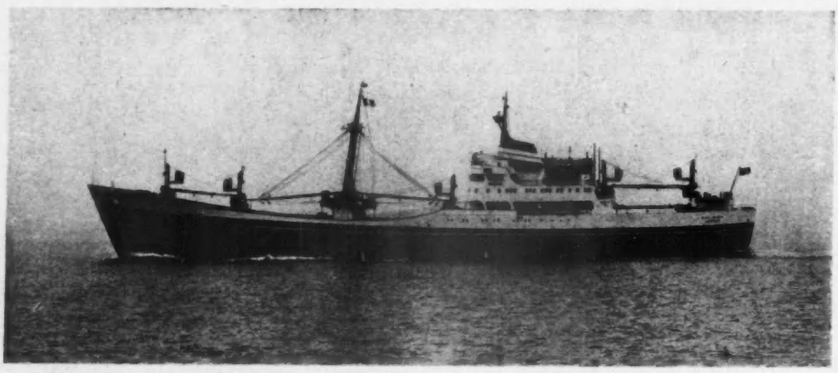
Barclay, Curle and Co., Ltd., completed to the order of The Hain Steamship Company, Ltd., the "Trevaylor" which is of shelter deck with long bridge design and has four holds and deep tank. For cargo handling there are one 50-ton, one 25-ton, four 10-ton and six 5-ton derricks operated by steam winches. The ship has a gross tonnage of 6500 and measures 470ft 6in in length, 61ft in breadth and 39ft in depth, and is propelled by a Barclay Curle–Doxford oil engine having four cylinders of 700mm bore by 2320mm combined stroke and fitted with a Bibby detuner.

The "Eastern Trader," which has an open shelter deck deadweight of 10,900 tons and a closed shelter deck deadweight of 13,000 tons, was built at the Neptune works of Swan, Hunter and Wigham Richardson, Ltd., for the Indo-China Steam Navigation Company, Ltd., and has the following dimensions: length between perpendiculars 450ft, breadth 62ft, and 40ft 4in depth to shelter deck. Cargo is carried in five holds and handled by eighteen derricks, including one of 20 ton and one of 50 ton capacity, served by electric winches. Three 330kW generators provide electrical power and the main machinery consists of a five-cylinder Swan, Hunter–Doxford oil engine arranged to burn heavy fuel and rated 5600 b.h.p. in service at 117 r.p.m.

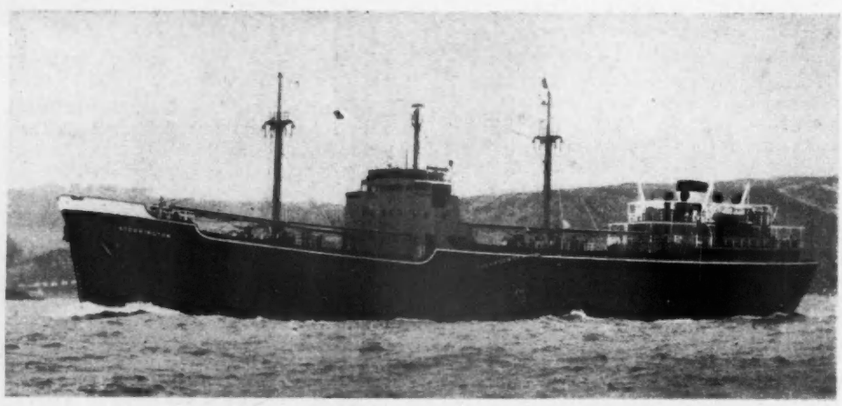
A number of ships joined the fleet of Andrew Weir and Co., Ltd., and included the "Rosebank," "Ashbank" and "Pinebank" built at Belfast by Harland and Wolff, Ltd., and the "Wavebank" and "Yewbank" constructed by William Doxford and Sons (Shipbuilders), Ltd. The principal particulars are length between perpendiculars 450ft, breadth 62ft 6in, depth 38ft 6in, and five cargo holds. Those ships built at Belfast are propelled by Harland and Wolff opposed-piston engines having six cylinders of 620mm bore by 1870mm combined stroke, while the Doxford ships carry a deadweight of 12,160 tons on a



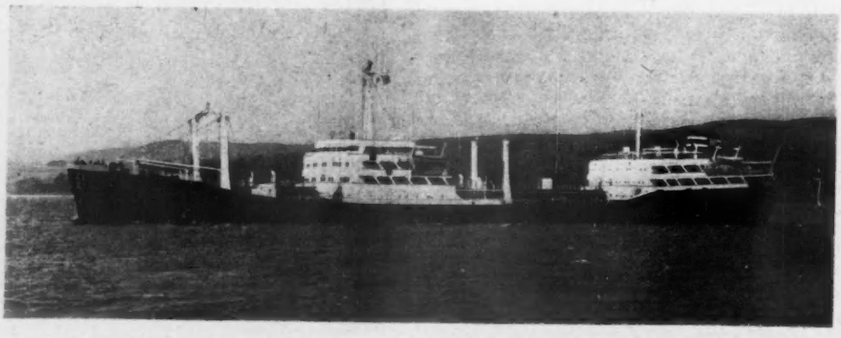
Refrigerated cargo liner "Royston Grange" for the Houlder Line, Ltd.



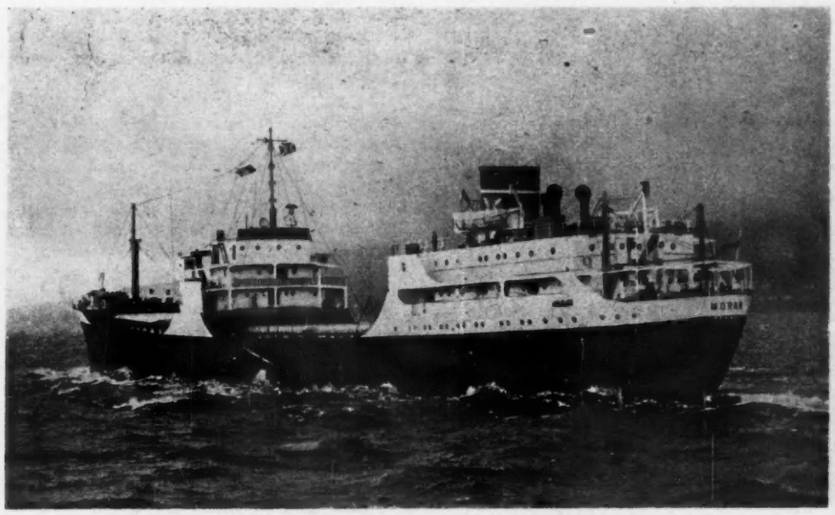
Cargo ship "Bulimba" for the British India Steam Navigation Company, Ltd.



Bulk and general cargo carrier "Storrington," for Stephenson Clarke, Ltd.



Oil tanker "British Swift," of 15,404 tons deadweight, for B.P. Tanker Company, Ltd.



Ore carrier "Morar," of 9250 tons deadweight, for Scottish Ore Carriers, Ltd.

closed shelter deck draught and are propelled by a Doxford oil engine having four cylinders of 700mm diameter by 2320mm combined stroke giving 4800 b.h.p. in service.

Among the ships completed at Govan by Harland and Wolff, Ltd., was the "Bulimba" and a sister ship "Bankura" for the British India Steam Navigation Company, Ltd. The "Bulimba," described in THE ENGINEER of May 22 and illustrated herewith, measures 395ft in length by 59ft beam by 32ft 6in in depth and has a deadweight of 7500 tons. There are three holds forward and one aft of the engine-room, each fitted with MacGregor push-button controlled hatch covers, and the cargo is handled by derricks and electric cranes. Four 350kW English Electric turbo-charged diesel-driven alternators meet electrical requirements and propulsion is by a Harland and Wolff six-cylinder, turbo-charged, opposed piston diesel engine developing a maximum of 6700 b.h.p. at 118 r.p.m.

The 5000 tons deadweight bulk and general cargo carrier "Storrington," seen in our illustration, was delivered to Stephenson Clarke, Ltd., by The Burntisland Shipbuilding Company, Ltd., and the ship is of raised quarter deck, self-trimming design, with machinery aft. The ship, which is equipped to navigate the St. Lawrence Seaway, has a length between perpendiculars of 327ft by 48ft 8in beam by 28ft 6in depth to raised quarter deck. There are four holds suitable for grab discharge and eight 3-ton derricks powered by electric winches. J. G. Kincaid and Co., Ltd., constructed the two cycle, trunk piston oil engine, of 500mm bore by 900mm stroke, and rated to deliver 1500 b.h.p. at 150 r.p.m.

Hall, Russell and Co., Ltd., built the "Santona" for the North Atlantic and the St. Lawrence Seaway trade of the Donaldson Line, Ltd., and the ship carries a deadweight of 2500 tons on 17ft 10in draught and the following dimensions: 270ft length between perpendiculars, 44ft 6in breadth, 26ft depth to shelter deck. Three holds take the cargo and are served by six 5-ton and two 7-ton derricks and electric winches. In the machinery space, located aft, are two 125kW diesel-driven generators and the main propulsion engine, a British Polar five-cylinder, single-acting, two cycle trunk piston engine developing 2000 b.h.p. in service.

Ore Carriers and Oil Tankers

Our illustration shows the ore carrier "Morar," which was described in the March 6 issue of THE ENGINEER and which was built for Scottish Ore Carriers, Ltd., by Lithgows, Ltd. The ship, the first British vessel to have free-piston exhaust gas turbine machinery, has the following main particulars: length between perpendiculars 407ft, breadth 57ft 3in, depth 32ft 3in, deadweight 9250 tons, and service speed 11 knots. No equipment is provided for handling the cargo which is carried in four centre-line holds fitted with "Ermans" hatch covers. For propulsion purposes there are three GS-34 free-piston gasifiers each of 1230 gas horsepower, supplied by the Free Piston Engine Company, Ltd., and a Rankin and Blackmore gas turbine of 2500 s.h.p., driving through Fairfield double reduction gearing.

To the fleet of the British India Steam Navigation Company, Ltd., was added the "Ellora," of 37,000 tons deadweight and built at Wallsend by Swan, Hunter and Wigham Richardson, Ltd. The ship, which measures 660ft by 90ft by 48ft, has a service speed of 16½ knots and carries the oil in thirty-three tanks served by four 1350 tons per hour pumps. Propulsion is by a set of Wallsend Slipway double-reduction geared turbines, taking steam at 600 lb per square inch and 850 deg. Fah. from two Babcock and Wilcox boilers and developing 16,000 s.h.p.

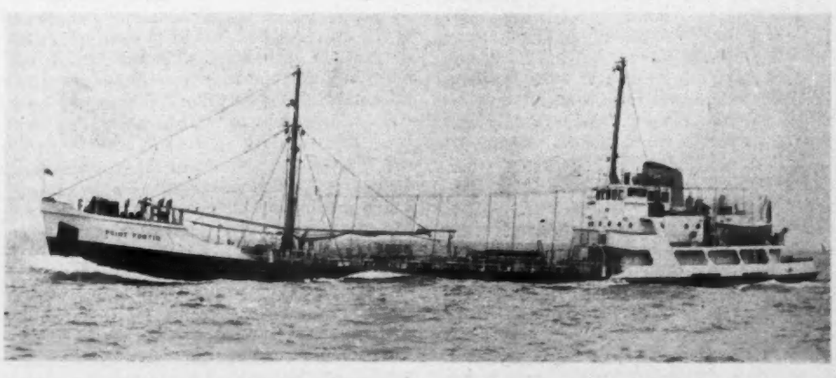
Among the tankers completed by Harland and Wolff, Ltd., was the "Eskfield," built at Govan for the Northern Petroleum Tank Steamship Company, Ltd., and the Field Tank Steamship Company, Ltd. A deadweight of 28,500 tons is carried on the following dimensions: length between perpendiculars 610ft, breadth 80ft 6in, and depth 45ft 6in, and there are twenty-seven oil compartments. Three 180kW diesel-driven generators provide electrical power and the main engine is a Harland and Wolff two cycle, opposed piston engine having seven cylinders of 750mm bore by 2000mm combined stroke.

Representative of the 25,000 tons deadweight size of tanker was the "Overseas Explorer," built by the Furness Shipbuilding Company, Ltd., for London and Overseas Tankers, Ltd. The ship is propelled by a set of Richardsons Westgarth double-reduction geared turbines which develop 7300 s.h.p. at 100 propeller r.p.m., and two Foster-Wheeler "D" boilers supply steam at 450 lb per square inch and 750 deg. Fah. Oil in the twenty-seven cargo tanks is handled by three 1000 tons per hour pumps located in one main pump room.

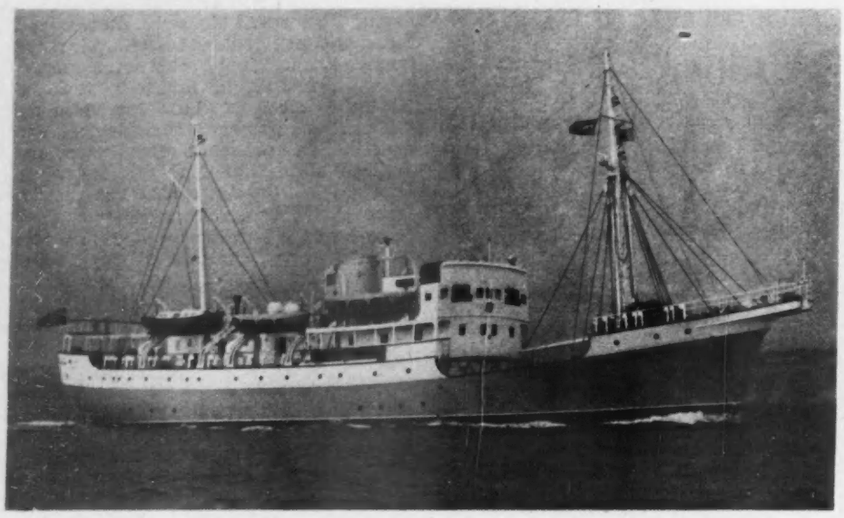
Smith's Dock Company, Ltd., delivered the 19,125 tons deadweight "Malaja" to the Charter Shipping Company, Ltd., and the ship measures 533ft by 71ft 3in by 39ft 2in. In the cargo pump room are four 300 tons per hour pumps and a service speed of 14½ knots is maintained by a set of Hawthorn Leslie double-reduction geared turbines of 7500 s.h.p. at 100 propeller r.p.m. Two Foster-Wheeler E.S.D. boilers provide steam at 530 lb per square inch and 800 deg. Fah., and two 450kW turbo-alternators meet electrical power demands.

One of the smaller units which joined the B.P. Tanker Company's fleet was the "British Swift," which we illustrate and which carries a deadweight of 15,404 tons on 29ft 4½in draught and the following dimensions: length between perpendiculars 495ft, breadth 69ft and depth 37ft. Thirteen of the twenty-seven cargo oil tanks are cathodically protected and there are two cargo pump rooms, each equipped with two 500 tons per hour pumps. The ship was constructed by Scotts Shipbuilding and Engineering Company, Ltd., and is fitted with a Scott-Doxford supercharged oil engine of 7600 b.h.p. and capable of maintaining a service speed of 14½ knots.

Built for the bunkering service of Shell Trinidad, Ltd., in the Gulf of Paria by Hall Russell and Co., Ltd., "Point Fortin" measures 204ft by 35ft by 16ft 5in and has a draught of 13ft 11in and a deadweight of 1440 tons. There are six port and six starboard cargo oil compartments and the ship, seen in our illustration, has two 40kW diesel-driven generators and is propelled by a Crossley HGN8/60 unidirectional two-stroke trunk piston engine developing 1000 b.h.p.



Coastal tanker "Point Fortin," of 1440 tons deadweight, for Shell Trinidad, Ltd.



Twin-screw lighthouse tender "Atlanta," for the Commissioners of Irish Lights

at 600 r.p.m. and driving a propeller through a Renk 3 to 1 reduction and reverse gearbox.

Short Sea and Smaller Craft

The "Colchester," a sister ship to the "Isle of Ely," was completed by the Goole Shipbuilding and Repairing Company, Ltd., for the Eastern Region Continental cargo services of British Railways. Of open shelter deck design, the ship measures 226ft by 37ft by 23ft and the holds and 'tween decks can accommodate forty-two large containers, for which no handling gear is provided. At a mean draught of 13ft 1¾in the displacement is 1905 tons and the deadweight 935 tons. A Ruston and Hornsby 8VOXM diesel engine delivers 1806 s.h.p. through a Hindmarch/M.W.D. 2 to 1 oil-operated reverse/reduction gear to give the ship a service speed of 13½ knots.

The Southern Region of British Railways took delivery of the car ferry "Freshwater" and the ship was built by the Ailsa Shipbuilding Company, Ltd., and described in The Engineer of November 6. This double-ended vessel can carry twenty-eight cars and passengers or 620 passengers with no cars on board. The ship has a length overall of 164ft by 42ft 6in breadth over sponsons by 10ft deep and draught of 6ft. Propulsion is by two Voith-Schneider size 14E cycloidal propellers, arranged one to port and one to starboard at each end of the vessel, and built by Brown Brothers, Ltd. The necessary power is developed by two unidirectional Crossley E.G.N. 8/65 diesel engines and the ship has a speed of 10½ knots.

Our illustration shows the twin-screw lighthouse tender "Atlanta," built for the Commissioners of Irish Lights by Philip and Son, Ltd. The ship has a length between perpendiculars of 185ft, a breadth of 38ft and a depth of 17ft, and in addition to four state rooms for commissioners, provides accommodation for eight officers, fourteen petty officers and eighteen ratings, as well as six lightsmen. Deck equipment includes one 3-ton and one 12-ton derrick and a towing winch having a stalling load of 17 tons. The English Electric Company, Ltd., supplied the propelling machinery which consists of four 304kW generators each driven by a mark 6SRKM diesel engine and two propulsion motors, each having an output of 750 s.h.p. at 140 r.p.m.

The Scottish Home Department took delivery of the fishery patrol vessel "Norna" from William Denny and Brothers, Ltd., and the main dimensions are: length 187ft, breadth 27ft 6in, and depth 11ft 6in. Three 30kW diesel-driven generators provide the electrical power and propulsion is by two M.48.1. British Polar diesel engines, each rated at 800 b.h.p. at 400 r.p.m.

During the year the quick-freeze fish factory trawler "Fairtry II" was handed over to her owners, Chr. Salveson and Co., by the builders, William Simons and Co., Ltd. The ship, which was described in the May 8 issue of The Engineer, measures 235ft by 48ft by 28ft. There is a stern ramp and a 270 h.p. trawl winch and complete factory equipment; propulsion is by diesel-electric machinery supplied by The General Electric Company, Ltd. This consists of three 535kW generators, each driven by a Ruston and Hornsby 5.VOXZ engine of 1340 b.h.p., and a double-armature motor of 2000 s.h.p. at 130 r.p.m.

Also having diesel-electric machinery was the trawler "Falstaff," which is of conventional design and built by Smith's Dock Company, Ltd., to the order of Hellyer Brothers, Ltd. The ship has a fish room of 18,250 cubic feet capacity. The English Electric Company, Ltd., manufactured the propulsion machinery, consisting of three 481kW generators, each driven by an eight-cylinder turbo-charged diesel engine, and a single armature motor delivering 1800 s.h.p. at 175 r.p.m.

National and International Aspects of Stress Analysis

By M. L. MEYER, B.Sc.(Eng.), A.M.I.Mech.E., A.M.I.W.*

Stress analysis nowadays is not only a field of the mathematical and physical sciences but also part of the engineering process in ensuring safe, efficient and economic products. In France and U.S.A., high-powered national organisations promote knowledge in this field. In this country the Stress Analysis Group of the Institute of Physics is concerned specifically with the subject, and its work needs to be publicised on a more national scale. Here, as in the fields of non-destructive testing and nuclear engineering, close collaboration between physicists and engineers at all levels is essential for technical progress. The Stress Analysis Group has initiated contact with stress analysts in other European countries including Russia, and the First International Stress Analysis Conference in Delft, 1959, has shown the general interest in and benefits of such international collaboration. A preparatory committee for future collaboration and for the organisation of a second international conference, to be held in 1961 or 1962, will be set up in the near future. Below, brief account is given of the Conference in Delft, and a few of the newer developments and applications of stress analysis discussed in Delft are reviewed, amongst them the wider use of the Moiré technique as practised in France and Belgium, the Hickson strain replica method, the further development of the German "stress probing extensometer," French and German work on brittle coatings and brittle strips, Russian work on composite models, and the use of destructive testing as a means of stress analysis.

Present Developments in Stress Analysis and Associated Subjects

MOST branches of engineering use stress analysis. The methods of stress analysis have been developed by mathematicians, physicists and engineers; they reach from the simplest calculation and test to highly complicated theories and experiments; they are based on certain common fundamental principles but vary in their applications. An increasing number of stress analysts, stress laboratories and equipment are employed in industry and, in certain progressive factories, stress analysis is now as much part of the engineering process as, say, production engineering.

It is, therefore, time to ask whether a group, committee or society exists, or should exist, where (*a*) stress analysts working in the various fields of development and applications could meet and discuss their common problems, (*b*) new methods and developments could be presented to those interested in promoting this branch of science and applying its results, (*c*) the requirements of industries could be brought to the notice of those occupied on similar projects in other fields, (*d*) attention could be given to training in the fundamentals of the subject, (*e*) international contacts could be established and followed up. This article is concerned with pointing out the present position in this country and abroad, and drawing attention to the desirability of having a generally known and accepted organisation to deal specifically with these questions.

In the author's opinion, the Stress Analysis Group of the Institute of Physics, which unites physicists and engineers in informal and friendly discussion and has initiated international collaboration in this field, would be the natural focus for the larger responsibilities if given support and publicity

* Postgraduate Department of Applied Mechanics, Sheffield University.

by the professional institutions most concerned. Particularly in experimental stress analysis, only the joint work of physicist and engineer can promise sufficiently rapid progress.

In the United States and France, separate and independent societies for stress analysis have been established, working with and partly supported by interested professional institutions, research associations and private firms. Both the Society for Experimental Stress Analysis (S.E.S.A.) and the Groupement pour l'Avancement des Méthodes de l'Analyse des Contraintes (G.A.M.A.C.), hold national meetings, periodically issue technical volumes and collaborate in committee with other institutions. In this country, the old-established divisions between physics and engineering and between the various branches of engineering cut across the field of stress analysis; consequently, the development is not carried forward on a broad front but in isolated advances that remain generally unknown far too long.

The only organised group in this country interested in all aspects of stress analysis is the Stress Analysis Group of the Institute of Physics. The Institute supports the Group and allows it considerable freedom for its work; moreover, the special "Subscriber" category of the Institute permits suitably qualified mathematicians and engineers to participate in the organisation and meetings of the Group so that, in addition to the main physical and mathematical aspects of stress analysis, the technical applications receive due attention. The disadvantages of this arrangement are that the work of the Group remains relatively unknown to the engineering world which could most benefit by it, that meetings and discussions are hardly, if ever, reported in the technical press, and that the two scientific journals published by the Institute of Physics can carry only contributions of predominantly physical interest. Many of the more technological papers discussed in the Group often appear in technical journals under the names of their authors without reference to the work of the Group.

The division of interests in this country revealed itself acutely when the Stress Analysis Group, following modern fashion in convening its annual meeting abroad in Delft, Holland, during April 1959, discovered to its surprise from the response and interest taken in Europe that it had actually convened a truly international conference on stress analysis. As the convener and technical organiser, as host in collaboration with the Dutch Instituut T.N.O. voor werktuigkundige Constructies, and now as one of several participating groups, it found itself with the task of representing British stress analysts on a national scale. Moreover, the success of the conference led to a preliminary decision, which has already found wide international support, that an international Standing Committee should be established, composed at the outset of one member and one deputy representative of the stress analysis interests in each of the nations that participated in the Conference at Delft.

This international committee would be charged with the task of maintaining liaison between the countries, "a living list of addresses" as Dr. Baud of Switzerland put it, and of inviting offers of hospitality for the next international conference which would possibly take place in two or three years' time† ; it would be empowered to widen the range of participating countries and the scope of collaboration. However, at the present stage a formal international organisation with its own secretariat was not envisaged, and there was agreement that present international collaboration should be restricted so as not to require more time, effort or finance than could be afforded by any existing secretarial arrangements of national organisations or national groups of collaborating institutions. (The arrangements suggested for the organisation of future international conferences are mentioned at the end of this article.)

Now, neither the Stress Analysis Group nor any other group, association or institution can at present claim to be "representative" of stress analysis interests in this country. The Stress Analysis Group occupies a favoured position because of its special interest in and regular discussions of all things stress analytical, because of the success of its international initiative and, consequently, its international connections and knowledge of the plans and possibilities for future collaboration. Furthermore, many of its members are also members of the various interested engineering institutions and large research associations and laboratories. However, all this still does not qualify the Group to represent British stress analysis internationally. It must be hoped, therefore, that the Group will find increasing support by and within interested professional institutions, research organisations and firms so that active British participation in future international work in this field can be assured and its benefits reach the widest possible circle of potentially interested persons.

One of the reasons for the interest shown internationally is the gradual emergence of stress analysis as a nucleus of a separate discipline of engineering. The development is fairly far advanced in the United States and France where S.E.S.A. and G.A.M.A.C. have established themselves as independent centres of information and foci for research. In Germany, active consideration is being given to the formation of a central group working in conjunction with the "Fachgruppe Messen und Prüfen" of the Verein Deutscher Ingenieure (VDI.). In the smaller European countries, the problem is perhaps not so urgent because their many unofficial channels of communication spread information sufficiently quickly and widely. However, in all countries there is a growing realisation that *measurement, analysis and testing*, primarily though not exclusively for stresses, form an increasingly important, increasingly specialised field of engineering with its own "philosophy" and inherent principles, and that a more formal training and centralised distribution of information may save effort and contribute to efficiency and further progress.

It is interesting to reflect on the similar problems in the evolution of non-destructive testing. Because of the novelty of this discipline, its well-defined field and obvious responsibility, it has overtaken stress analysis in the development of special training, of societies and groups acting as centres for information and professional interest, and of international collaboration. Here, again, the Institute of Physics influenced the development in this country by forming a Non-destructive Testing Group which collaborates with other groups in this country and abroad. It is equally interesting to follow the progress in destructive testing where emphasis is shifting from the testing of materials to the testing of components to investigate their various possible causes of failure. Both these developments cannot fail to influence the methods used by the stress analyst: for example, the required precision of an analysis depends on the ascertainable reliability of the object; the concept of "fail-safe" is based on the existing possibilities of calculating and measuring stresses and of testing the components destructively and non-destructively.

On the other hand, both testing and stress analysis can be fully utilised only when the actual or expected service loads and stresses can be measured or closely estimated on a background of experience gained by measurement. This close relation of measurement, analysis, and testing has been recognised in particular in aircraft engineering; other industries increasingly find it to their advantage to adopt some of the methods pioneered in aircraft engineering. For instance, a design for limited life can be said to be safe and economic when the service loads have been measured and can be simulated in fatigue tests, when stress analysis then ensures the most favourable stress distribution, where fatigue is known to start eventually at certain accessible points, and when finally non-destructive testing can discover and check any propagation of fatigue at these points so that the affected component can be taken out of service in good time.

If, therefore, *the combination of measurement, analysis and testing can be regarded as a separate branch of science and engineering*, linking the knowledge of materials, particularly metallurgy, with engineering design for whatsoever purpose, and requiring specialists in its various fields, a case could well be made out for national and international collaboration in the professional interests of research, dissemination of information and training. A formal training in this branch would not imply a new subject in an already overloaded college or university syllabus; the usual course in "Strength of Materials" already covers a special field of this b nch and could be adapted by suitable alterations to cover the wider field. It is not a matter of imparting more factual knowledge but of more basic thinking adapted to modern engineering with its increasing content of physical principles. Since non-destructive testing must eventually enter into the ordinary syllabus, the necessary reorganisation may as well be undertaken along more fundamental and comprehensive lines.‡

As regards research and the dissemination of information, a few examples taken from the discussions of the first International Conference on Stress Analysis in Delft and a brief account of its general organisation and importance may serve to show the advantage of wider collaboration, an advantage that already accelerates the progress in the field of non-destructive testing.

Some Items Discussed in Delft, 1959

In this country, the method of the Moiré fringes is applied only rarely in stress analysis, and then mainly to problems of irregular bent plates, which require a fairly large equipment. In Germany, the very name of the method was unknown before the Delft Conference. In France and Belgium, however, the method is used more widely and with simpler devices for the measurement of regional elastic and local plastic strains, either on plane metallic surfaces or inside transparent three-dimensional models. Fig. 1 shows the Moiré pattern and its evaluation in terms of the axial elongations in a stretched notched steel plate at the point of fracture[1]; note the

† In fact, at the invitation of the German Group, a first meeting has been already arranged to take place this month for a discussion of the next international conference.

‡ In a more advanced and practical context, the postgraduate course in Applied Mechanics given in the University of Sheffield already covers a great part of the studies appropriate to this branch of engineering by combining in the syllabus for its Diploma several short courses (two to five weeks), which can be taken consecutively or separately, on stress determination, vibration, noise, fine measurement, electronics, friction and wear, non-destructive testing and other special subjects.

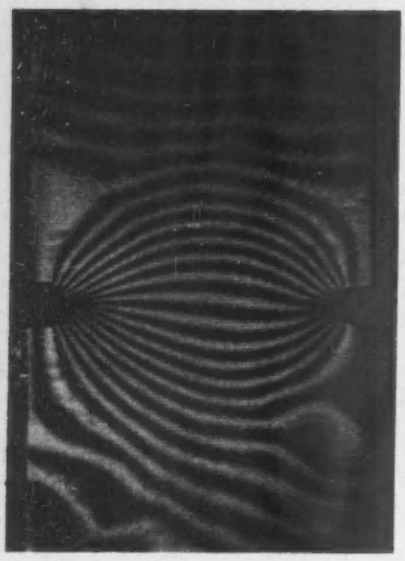


Fig. 1—Typical Moiré pattern of notched tensile specimen

region of low elongations at the centre of the reduced cross-section. Fig. 2 shows the elastic and plastic Moiré patterns in an axial plane of an Araldite cylinder compressed centrally between two spheres[2]; the greater concentration of the plastic strains is evident from the pattern itself, the distance between fringes being roughly inversely proportional to the strains.

For the purpose of these illustrations a master grid of 100 to 500 lines per inch has been photographed on to a film with strippable backing, the emulsion being affixed to the surface of the metal or of a cast half-cylinder of Araldite. The backing is then removed and, in the case of the cylinder, the other half is cast on to the surface with the grid. The dummy grid, which is not distorted during loading, is photographed on to a glass screen or transparent film which can be held in front of the grid distorted by loading or loosely attached to the test surface with a suitable liquid. The two grids appear superimposed on the photographs and the strains are evaluated from the distances between the fringes formed by interaction of the grids. The sensitivity can be increased by a factor of about fifty if the two photographed grids have slightly different line densities initially; the differences in the fringe distances between the loaded and the unloaded state then determine the strains. For measurement at high temperatures, the active grid may be photo-engraved into the metal surface and the negative of the process used as the dummy grid.

Another method that supplies a regional deformation pattern for quantitative evaluation is the Hickson Strain Replica Method developed at the Royal Aircraft Establishment and demonstrated briefly at the Conference for the first time.[3] An irregularly spaced orthogonal network of straight

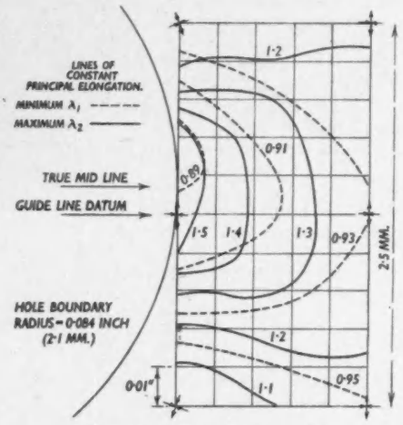
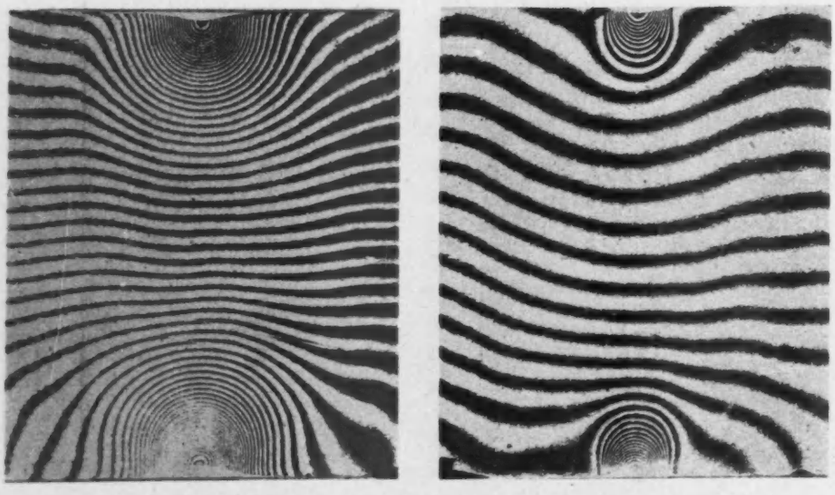


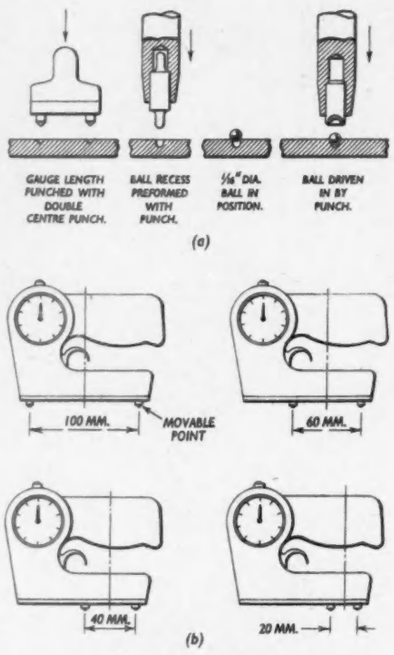
Fig. 3—Evaluation of strain replicas

lines is lightly scratched into a reasonably polished metal surface with fine rouge paper; additional guide lines drawn with a sapphire point permit identification of the individual scratches. A dimensionally stable replica is taken in a fusible alloy covering a mushroom-shaped metal platen of $\frac{3}{8}$in diameter, which is electrically heated to a suitable temperature in a spring loaded gun and then propelled against the test surface. The drawing of scratches and the replication take at the most two minutes, and the replicas taken under the various loading conditions or at various stages of assembly or service can be measured out at a convenient remote time and place under a microscope with a micrometer eyepiece and a special sliding stage that allows adjustment of a pair of replicas to pseudo-coincidence. The method automatically



(*a*) Elastic deformation obtained by stress freezing at 100 deg. Cent.
(*b*) Plastic deformation obtained by cold loading.

Figs. 2 (*a*) and 2 (*b*)—Three-dimensional use of Moiré patterns on two compressed cylinders of Araldite



Figs. 4 (*a*) and 4 (*b*)—Stress-probing extensometer developed in Germany

compensates for temperature changes within limits; the scratches are not obscured by Lüders lines or plastic undulations of the surface. The region observed is more restricted and the measured strains are more localised than with the Moiré method. Fig. 3 gives as an example the evaluated principal elongations in the neighbourhood of a hole in a tensile strip and shows the greater sensitivity of this method compared with the Moiré method.

A better knowledge of developments abroad would probably have caused more interest to be taken in this country in the "Stress-probing Extensometer" (Setzdehnungsmesser) developed in Germany at the Bundesanstalt für Materialprüfung. Figs. 4 (*a*) and 4 (*b*) show its original form and application[4]: a gauge length is marked out by pressing two $\frac{1}{16}$in steel balls partially into the test surface as shown in Fig. 4 (*a*); in a more recent improvement, the measuring points are formed by two hemispheres bonded at a given distance to a strip of impregnated paper or metal foil that can be affixed to a test surface in the same manner as a resistance strain gauge. The instrument Fig. 4 (*b*), with suitably adjusted base length, is then held manually against the two protruding spheres or hemispheres before and during loading, and their exact distance is read off the dial gauge. Since reliable measurement on gauge lengths less than about 2in is difficult, an additional "transfer" device has been developed for gauge lengths of $\frac{3}{8}$in and $\frac{3}{4}$in. With a little experience and knowledge of the systematic error of the dial gauge, elongations of 2×10^{-5}in can be measured on gauge lengths from $\frac{3}{8}$in to 4in. The instrument is robust, simple to handle, needs no ancillary circuits and can explore rapidly and economically the strains at many prepared points.

Civil engineers may be interested in a simple static pressure gauge for permanent installation developed in Germany[5]: Two identical thin steel plates are welded together on their circumference, and the narrow space between them is connected to the outside by two oil pipes. When the device is placed inside concrete or between steel members of a

structure, the plates are pressed together by the structural forces. If oil is now pressed between the plates and the oil pressure reaches a value equal to the external pressure, the plates are forced apart very slightly until the uncovered release opening again reduces the oil pressure, unless a constant small flow of oil is maintained. The device needs no attention, contains no perishable parts, and can be left in the structure and operated whenever required. A single hand-operated hydraulic system will serve an entire structure with many check points.

Mechanical engineers may find useful applications for a new British design of static and dynamic displacement pick-up[6]: any slight displacement of a small aluminium screen interposed between the primary and secondary coil of an instrument transformer strongly influences the output voltage of the secondary. The advantages of this Electric Screening Transducer are that the moving part need only carry a small aluminium shield of negligible inertia, that the sensitivity of the device is limited only by the zero stability of the associated circuits and can be made to correspond to about 4×10^{-6}in screen displacement, that the output is linear within $\pm$ 2 per cent up to about $\frac{1}{8}$in displacement, a range of 10^6 coverable by a reading instrument with range switch, and that unlimited overtravel is permissible.

Brittle coatings that crack at a known tensile strain and are reliable and robust enough for application and testing under workshop and field test conditions would seem to provide an attractively simple and comprehensive means of stress analysis. Amongst the more recent developments in this field, a water soluble lacquer introduced by the Royal Aircraft Establishment may be mentioned[7]; it is easily applied and reliable, but unfortunately gives useful results only within a limited range of humidities (52 to 62 per cent). In France, the Union Technique de l'Automobile et du Cycle have pursued the method of flame spraying powdered undissolved resin and have obtained successful results accurate to within 20 per cent or even 10 per cent under workshop conditions.[8] In Germany, the Bundesanstalt für Materialprüfung is at present developing an entirely new idea: eloxidised aluminium foil of 0·004in thickness is cemented to the test surface and, under favourable conditions, indicates strains of about $0{\cdot}5 \times 10^{-3}$ by cracks in the oxide layer.[9] This method is entirely independent of humidity, a major source of trouble with the other known methods.

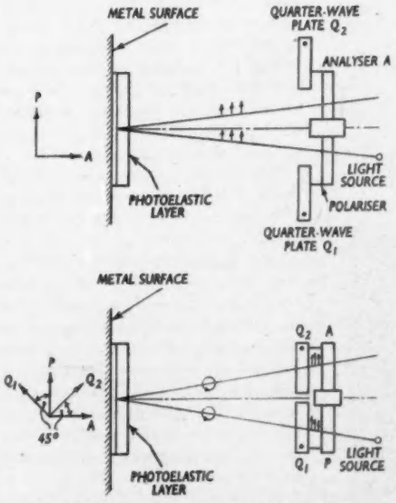
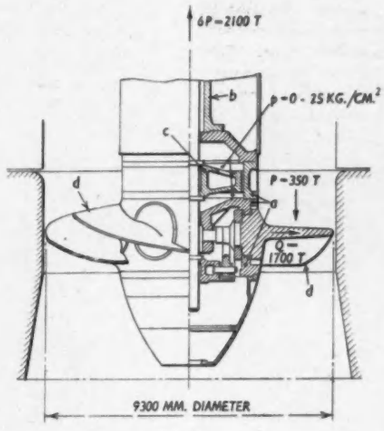
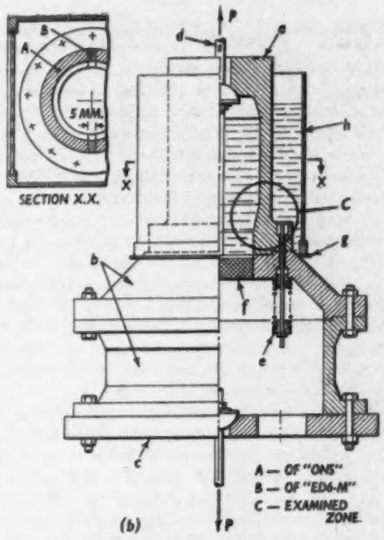


Fig. 5—Strain measurement by photoelastic layers



a. Casing.
b. Shaft.
c. Piston of servomotor.
d. Blades.

Fig. 6—Propeller turbine runner



a and b. Transparent and opaque parts of model.
c. Rigid plate.
d. Rod with strain gauges.
e. Spr ng controlling tightness of connection
f. Elastic stopper for immersion bath.
g. Sea ing foil for immersion bath h.

Fig. 7—Layout of compound optical model of propeller turbine shaft

The technique of photoelastic coatings has also gained in versatility for industrial applications by the development of a portable optical equipment and an additional instrument for rapid determination of the separate principal stresses at selected points by oblique incidence.[10] Fig. 5 gives the principle of the equipment, the upper sketch showing the set-up for observation of the isoclinics, the lower sketch that for observation of the fringes. Thin photoelastic layers are sprayed on; thicker layers of about $\frac{1}{32}$in to $\frac{1}{8}$in are made of partially cured, siliconised Araldite plates that are preformed at an elevated temperature on the test surface itself and can then be cemented cold.

Model testing plays an increasingly important role in the preparation of new designs. Very simple models made out of, e.g., folded cardboard, which behaves strictly elastically, can yield valuable information. Complicated structures can be analysed fairly completely by complex models: Figs. 6 and 7 show, as an example of current Russian work in this field, a propeller turbine rotor and one of its details, both analysed extensively with models made of "Perspex" with photoelastic inserts[11]: dial gauges and resistance strain gauges are used to measure deflections and strains in members in order to find the forces, moments and general stress distributions, whilst the photoelastic methods of direct transmission, oblique incidence and scattered light are used on the same models to obtain the stress concentrations.

The early engineers of the 19th Century made extensive use of destructive testing as a means of analysing the stresses and strength of components and structures. This type of testing, combined with the modern methods of measurement and statistical analysis, is applied again more frequently nowadays, and several contributions dealt with its application, e.g. to welded connections and the size effect in fatigue.

Although the Delft Conference occupied itself largely with scientific aspects of stress analysis, the examples given in this article will suffice to show that it offered much of interest to engineers. Its proceedings, which the Institute of Physics has agreed to publish, albeit in a much abbreviated form, will be a valuable source of reference for new engineering applications and a starting point for much further applied research. The Conference, which was opened by Professor Biezeno, one of the founders of the International Congress of Applied Mechanics, was attended by members from fifteen nations; fifty-two technical papers contributed by workers from six different countries were presented to it. In addition, recent stress analysis work and trends in France, Germany, Holland and Great Britain were reviewed in four invited contributions. The British Stress Analysis Group had sole responsibility for the technical arrangements of the Conference, i.e. the selection of papers, the choice of group rapportage or individual presentation, and the timetable; the Dutch Instituut T.N.O. took care of the local arrangements and the Technical University of Delft provided the facilities. These arrangements proved so successful that a meeting called to consider future international conferences in this field unanimously recommended similar arrangements: a national group offering hospitality for a future conference should have undivided responsibility for all arrangements, once the date and place of venue had been found internationally acceptable.

The Delft Conference also succeeded in drawing together stress analysts working in the various countries; international contacts and collaboration will be much stronger in future than they were before the Conference. The question raised at the beginning of this article, therefore, is also whether the scientific and engineering interests of this country wish to support and take an active part in future European and wider international common activity in this technical and scientific field by following up the initiative taken by the Stress Analysis Group of the Institute of Physics.

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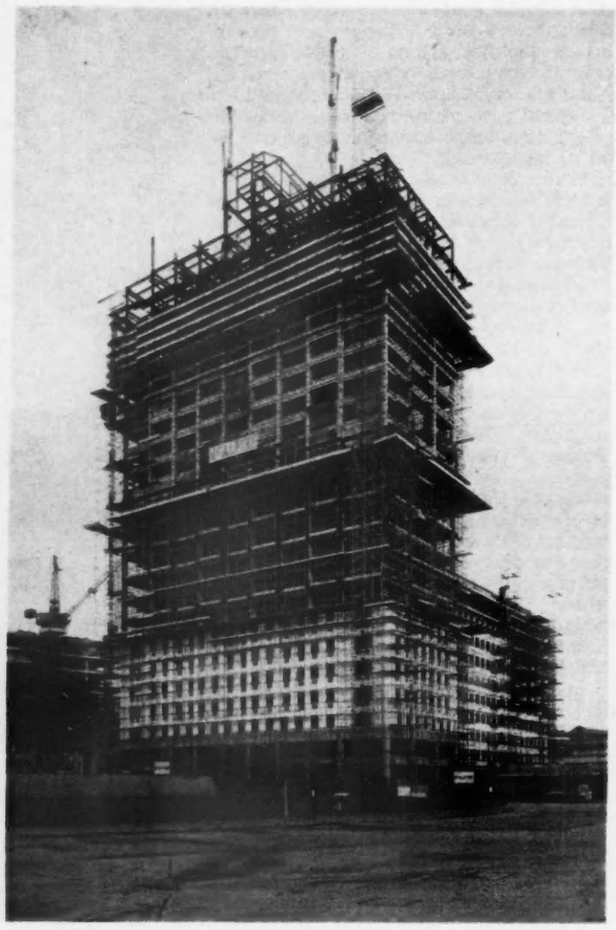
The "Shell" Centre

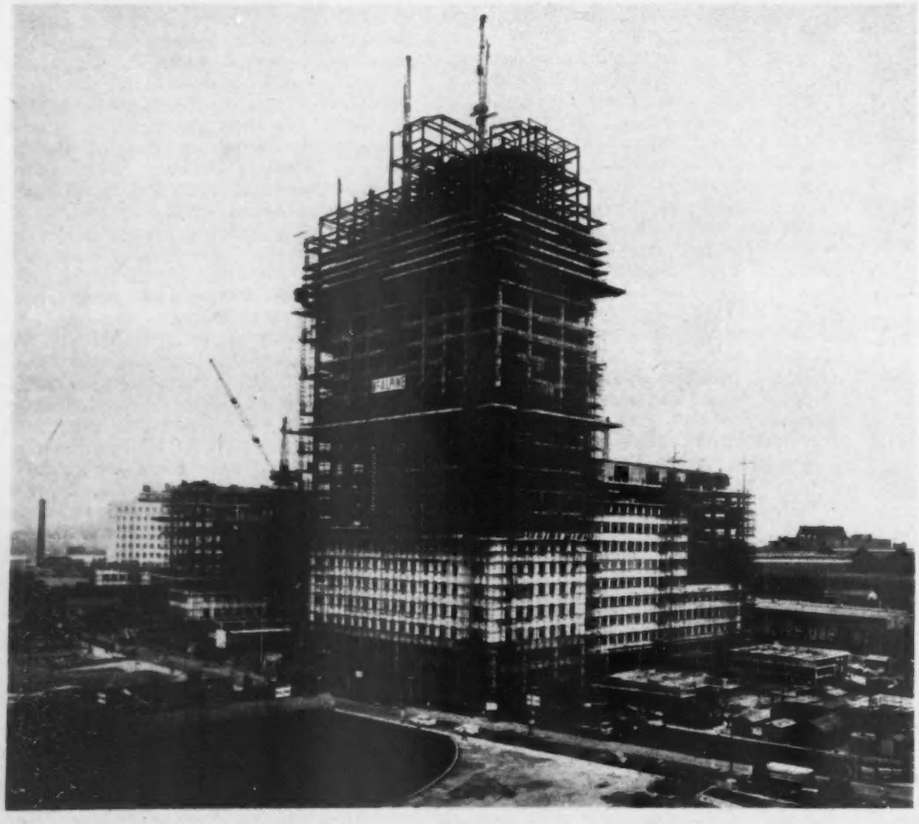
Rapid progress was made during 1959 on construction of the buildings of the Shell Centre on the South Bank in Central London. Erection of the steel framework of the 350ft high tower block was completed in December, and construction of the floors and roofs will be finished in the near future. This block is 174ft by 78ft in plan, plus a projecting wing 57ft by 15ft. Its basement is nearly 40ft deep and will contain the main boiler house and refrigeration plant for the whole Centre. Above ground, there are twenty-six floors in all, of which the tenth, twenty-fifth and twenty-sixth will constitute plant floors. Fourteen lifts will be installed ; ten will run the full height and operating speeds will be up to 800ft per minute. The building is to be air-conditioned throughout.

The main foundations for this tall building had to carry loads of 3000 tons and the consulting engineers evolved, and developed in conjunction with the contractor, large bored-pile cylinders of 7ft diameter extending about 100ft below ground surface and belled out to 15ft diameter at their bottoms. This relatively new type of foundation proved successful and economical and has since been adopted for numerous other important structures as has been described in this journal.

The framework of the building was governed by certain essential restrictions, notably that diagonal wind bracing could be utilised only in certain of the transverse frames and was particularly limited in the portion below the second floor, that exterior columns had to be of such shapes as would permit flush interior faces to the walls, and that depths of main beams and sizes of interior columns had to be as small as reasonably practicable ; also the battery of lifts had to be situated in a position eccentric to the main axes of the building and a large vertical shaft had to be incorporated to enclose three chimney flues from the boiler house. The framework was thus designed throughout in steel and was in effect "broken" above second floor level. Below this level, the main transverse frames were designed and constructed as two-storey, three-bay portals, of which the stanchions are welded box sections, some with inner web plates and all fabricated in one length of 70ft, complete with haunches for site welding the joints to the portal beams at ground and second floors. The portal frames are interconnected longitudinally at these floors by main beams, also with rigid joints to the stanchions, to provide for the longitudinal wind forces in conjunction with the small amount of wind bracing next to the lift shafts. Additional stanchions in the lift and staircase areas are of welded I-sections.

The steelwork above the second floor is carried on specially designed steel bearings fixed on top of the main portal frames ; it was designed to act as a rigid frame working in conjunction with the wind bracing, which consists of four panels within the 27ft 6in centre bay and two panels 20ft wide alongside the lift shafts. Almost all the stanchions are of welded I-section, the largest 37in by 20in. A special connection, incorporating a welded haunch and end plate and using special grade 65/75 ton U.T.S. high-strength bolts, was developed for the fixed-ended main beams and was subjected to full-scale testing before work began. In this part of the building, rigid connections are also used for the longitudinal beams to provide rigid frame action against wind forces in this direction. The total weight of structural steelwork in the tower block is 6500 tons. It was fabricated in unison by the Cleveland Bridge and Engineering Company, Ltd., and Dawnays, Ltd., and erected by the former firm.





The suspended floors through the tower block are *in situ* reinforced concrete, generally 5in thick. Temporary timber protective screens enabled construction of these floors and of the casings and claddings to follow closely behind the steelwork erection, and when the last-named was finished on December 22, concreting had reached beyond the twenty-second floor.

Progress on the eleven-storey buildings in the Shell Centre also was rapid during 1959 and in several instances record speeds were achieved by the main contractor, Sir Robert McAlpine and Sons, Ltd. The architects for the Shell Centre are Easton and Robertson, Cusdin, Preston and Smith and the consulting civil and structural engineers are Scott and Wilson, Kirkpatrick and Partners. The consulting electrical engineers are Ewbank and Partners, and G. N. Haden and Sons, Ltd., are responsible for the design and installation of the air-conditioning, heating and associated services.

Rubber Technology and Standardisation

By F. H. EDWARDS, B.Sc.*

THE world demand for rubber under expanding industrialisation is likely to absorb not only the output from natural resources but also is being and likely to be supplemented increasingly by synthetic rubber production. In addition, the synthetic rubbers and new polymers have also to meet demands for special qualities, such as resistance to oils and solvents, resistance to extended temperature ranges, both low and high, &c., so that it is not surprising that research, development and standardisation are receiving major attention by all industrial powers.

Two conferences which recently took place in the U.S.A. showed that the rubber and associated industries are cognisant of the situation and are adequately organised to meet it. These were the International Standards Organisation, Technical Committee No. 45, for rubber, which met in New York on October 25–31, 1959, and the International Rubber Conference at Washington, on November 8–13, 1959. The former represents perhaps the maturity of the rubber industry in its endeavours to standardise international methods of testing, which is now reaching the stage where there are a sufficient number of agreed test methods to enable product specifications to be considered, while the latter typifies the progressive outlook of the industry both in its researches for new materials and the development of newer materials which have reached the development stage.

International I.S.O. Technical Committee 45—Rubber

The eighth meeting was attended by fifty-nine delegates from ten countries, Canada, France, Germany, Italy, India, The Netherlands, Sweden, United Kingdom, U.S.A. and U.S.S.R. being represented. The meeting was opened by Admiral G. F. Hussey, Jnr., of the American Standards Association, and Mr. J. M. Buist (U.K.) acted as chairman throughout the meeting. There were four plenary sessions and sixteen working groups had meetings. The New York meeting was particularly important as marking the end of a transitional period and a future wherein the responsibility for the working group programmes will be shared by a larger number of countries. An important decision was to limit the number of working groups but to allocate to each a number of related subjects, to which additions could be made later as the need arose. The new working groups will be concerned with natural and synthetic rubbers and are constituted as shown in the Table below.

Perhaps it should be stated that the International Standards Organisation does not prepare international specifications but produces I.S.O. Recommendations which represent the majority decision of member countries. It is hoped that countries will apply the recommendations not only for international purposes of interchange but will also adopt them in their national specifications, which latter, it might be said, is the policy of the British Standards Institution.

The preparatory work involved in the formulation of the I.S.O. Recommendation is performed by the working group, which considers first all the national specifications appertaining and generally pursues a course of investigation usually involving experimental work before the working group is able to prepare a draft I.S.O. Proposal. This is placed before the TC/45 plenary session for approval, amendment, &c. If approved, the proposal is circulated to the member countries of I.S.O. for postal ballot. If accepted, the I.S.O. Recommendation is formulated by the general secretariat. It will be inferred that the process is not a rapid one and that compromises must be accepted at times in order to obtain agreement, but it does assure that the subject matter has received responsible and detailed investigation.

Decisions taken at New York included resolutions : (*a*) to submit to the general secretariat a draft I.S.O. Recommendation for the determination of impact brittleness temperature and (*b*) for the secretariat to submit for postal approval amendments and additions to existing I.S.O. recommendations for the determination of stress-strain and hardness. Larger tolerances are proposed on dimensions of the existing tensile test piece and an additional smaller test piece is suggested. In the hardness test the tolerances are tightened on ball sizes and loads and a new, small ball indentor with corresponding loads is proposed for use on samples of substandard thickness. (This was originally called the micro-hardness test.)

It was also resolved that draft I.S.O. proposals should be submitted for postal approval for conditioning and test atmospheres, determination of volatile fatty acid number of latex, determination of nitrogen in latex, determination of coagulum content of latex, testing the resistance of vulcanised natural and synthetic rubber to liquid, determination of compression set of vulcanised natural and synthetic rubbers, preparation and testing of the adhesion of vulcanised rubber-to-metal where the rubber is assembled to one metal plate and preparation and testing of the adhesion of vulcanised rubber-to-metal where the rubber is assembled to two metal plates. In addition, the plenary session gave attention to, and in many cases approved, documents concerning product specifications, determination of copper and manganese, chemical and physical tests on raw rubber, ageing (resistance to ozone and light ageing), electrically conductive rubbers, cellular rubber testing, working group procedure, terminology, classification of vulcanised natural and synthetic rubbers.

* Bragg Laboratory, Naval Ordnance Inspection Establishment, Sheffield.

TABLE

Working group	Title	Convening country	Subjects covered*
A	Chemical tests	Italy	Tests on raw natural rubber for dirt, rubber hydrocarbon, volatile matter, ash, copper and manganese (II) ; extraction methods, polymer estimation, carbon black, ash and total fillers, sulphur (III).
B	Latex tests	France	Mechanical stability, sampling, dry rubber content, total solids, alkalinity, K.O.H. number (I) ; density, volatile fatty acids, preparation of dry film (II) ; iron, nitrogen, colour, chemical stability (III).
C	Physical tests on unvulcanised rubber	U.S.A.	Sampling, Mooney viscosity, Mooney rate of cure, mixing and vulcanising, evaluation of vulcanisates (II).
D	Static tests	U.S.A.	Hardness, tension stress-strain, tear strength (crescent test piece), rubber/fabric adhesion test (I) ; Delft tear-test, rubber/metal bonding, micro-hardness, resistance to liquid (II) ; compression and shear stress-strain (III).
E	Dynamic tests	Germany	du Pont abrasion (I) ; low temperature tests, compression set (II) ; rebound resilience, creep and stress-relaxation, abrasion (constant torque method), dynamic modulus, damping factor (III).
F	Ageing and degradation tests	U.K.	Resistance to crack growth and flex cracking, acceleration ageing (I) ; light ageing, resistance to ozone (II) ; dynamic ply separation (III).
G	Electrical and ebonite tests	U.K.	Electrically conductive rubber (II) ; resistivity, permitivity, power factor, breakdown strength (III) ; plastic yield, impact strength and cross breaking strength of ebonites (III).
H	Cellular rubber tests	U.K.	Density, thickness, compression stress-strain, compression set (III).
J	Classification of vulcanised rubbers	Netherlands	—
K	Product specifications	Either U.S.A. or Germany (awaits decision of postal vote)	—
L	Terms and definitions	France	—

* (I) I.S.O. Recommendations accepted or draft I.S.O. Recommendations prepared.
(II) Methods of test and subjects under discussion.
(III) Methods will be discussed or deferred after early discussion.

International Rubber Conference

The International Rubber Conference which was sponsored by the Rubber Division of the American Chemical Association, A.S.T.M., Committee D-11, and the Rubber and Plastics Division of A.S.M.E., was attended by over 1500 delegates, including 110 overseas visitors, of which over forty were from the United Kingdom. There were seventy-two papers presented, of which the foreign contribution was twenty-eight, thirteen coming from the U.K. authors, whose subject matter ranged between equipment and processes, elastomers, tyres, advances in test methods, ageing, classification, statistical methods, theory, elastomer reinforcement, adhesion, latex rubbers, polymer and polymeric structures and vulcanisation. The Conference was opened by Wallace R. Brodie, Science Adviser to the U.S. Secretary of State, his theme being the international implications of the development of science and technology. The full proceedings, including the technical papers, were published in book form and presented to delegates in advance of the meeting.

It might be said that the conference produced a wealth of information of interest to the scientist and technician as well as providing a meeting place for valuable but less formal discussions. The conference included a small exhibition relating to synthetic rubbers, processing machinery and testing equipment.

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

LIGHTWEIGHT DIESEL TRAINS

SIR,—Mr. Shipway's letter in your issue of December 11 finishes with the positive statement that bad riding of railway vehicles is due to lack of weight. The opinion that good riding can only be obtained by weight is an old one, advanced when lightweight rail cars were first introduced on railways, but the fact remains that there are many lightweight rail cars in service which give a better ride than some standard stock. It is surely a question of correct springing and spring control, combined with bogie design eliminating wearing parts.

With the increase in ratio between gross and tare weight with lightweight construction the difficulty of achieving good riding in both empty and loaded conditions is further complicated by the comparatively narrow range of permissible floor height, but it can be done. There are running on British Railways lightweight twin units which give a very reasonable ride at maximum speed (62 m.p.h.) both empty and fully laden with a normal complement of 125 passengers. During the strike in 1958 one of these twin sets embarked a total of 384 passengers but the riding of the vehicles was in no way improved by the extra weight. A possible easy solution of the floor height problem is offered by pneumatic suspension between body and bogie, with axle-box suspension of rubber in shear type or present conventional springs, but here again suitable damping control is essential.

The other partner in the good ride of course is the track and this is more likely to remain in good condition if unnecessary weight is eliminated.

A. H. SOMMER

Waterford,
Hertford,
December 23, 1959.

LUBRICATION SCIENCE AND TECHNOLOGY

SIR,—The book review on *Lubrication Science and Technology* published in the March 13, 1959, issue of THE ENGINEER has just come to my attention. It should be noted that this particular edition is a publisher's hard bound version of *ASLE Transactions*, Volume I, No. 1. The use of the title *Lubrication Science and Technology* has been discontinued for subsequent hard bound editions. I am pleased to note that you feel the volume contains considerable worthwhile information, but your remark that the papers are somewhat "ill-assorted" must surely be based upon unfamiliarity with the manner in which the transactions of engineering organisations are published. The articles published in such proceedings are based on papers presented at technical meetings. Thus they cover a wide range of subjects and cannot be expected to fit together like the chapters of a novel. Since each paper is a separate topic, the reader can read them in any order he chooses.

The remarks about the duplication of activity in American engineering societies seems to me to be out of place in a book review and appear to be based on a lack of understanding of conditions. A few comments on the subject are required to offset the misconceptions being propagated by your remarks.

Of course "it is a pity" that there are two organisations with activities in the lubrication field! However, it should be borne in mind that, for years, there was no organisation which covered the broad aspects of lubrication and that persistent efforts to form a Lubrication Division in ASME, all met with failure. As a result, the American Society of Lubrication Engineers was formed in 1944 to meet the need brought about by the growing realisation of the importance of applying a scientific approach to lubrication problems. In the fifteen years since its inception, the membership, which includes chemists, metallurgists, physicists, &c., as well as mechanical engineers, has grown to over 3000. You mention that ASME has a Lubrication Division. This is quite true, but it was not formed until ASLE had been in existence for ten years, and it has less than one-tenth of the membership of ASLE.

As far as the publication of materials is concerned, last year ASLE published more than half of all the technical articles on lubrication that were published by all U.S. technical societies combined. Because of this and because it has taken an active role in helping industry solve its lubrication problems ASLE has won for itself a strong position among U.S. technical societies and is rapidly gaining a similar reputation abroad.

JOHN BOYD,
Editor

ASLE Transactions,
Pittsburgh, Pa.
December 16, 1959.

NOISE ABATEMENT

SIR,—Many will commend the setting-up of a Government Committee to investigate noises to which everyone nowadays are subjected, both at work and play, in order to reduce them. We probably know less about the physical damage caused by noise than from any other cause, due, I suppose, from the paucity of knowledge of the mechanism of hearing. For this reason, the views of physicians are anticipated with interest. Government investigations should not be confined to the purely irritating noises of motor-cycles, pneumatic drills, &c., but with an endeavour to give the public some appreciation of what noise means to them. In other words, to dispel some of the ignorance of the matter.

You have welcomed the Government's decision to set up this committee, but your comments referring to the rising generation not being very much perturbed by noise, and of school homework being done to the accompaniment of jazz music, surely only illustrate lack of appreciation of the effects of noise. "Music While You Work" for type-setters, &c., is in another category, aimed at relieving tedium in periods of monotony. Damage to the ear by noise is cumulative, and may be one of the reasons why it is resisted most by the middle-aged and the elderly.

There is now evidence amongst organised bodies in this country of greater awareness of noise troubles, as indicated by lectures and articles in recent months. As we have been trailing behind other countries in restrictions and penalties for offensive noises, perhaps our progress will now be quickened.

C. J. POTTS, A.M.I.Mech.E.

Kenilworth,
Warwickshire,
January 4, 1960.

Book Reviews

The Industrial Challenge of Nuclear Energy III—Stresa Conference. Part I. Published by the Organisation for European Economic Co-operation, European Nuclear Energy Agency. Paris: O.E.E.C. Publications, 2, rue André-Pascal, Paris (16e). Obtainable from H.M. Stationery Office, P.O. Box 569, London, S.E.1. Price 18s. 6d.

THE Stresa Conference on Industrial Prospects in Nuclear Energy, organised last May by E.N.E.A., was the third O.E.E.C. information conference in a series with the general title "The Industrial Challenge of Nuclear Energy." Previous conferences were held in Paris and Amsterdam in April and June, 1957. The Stresa Conference was attended by 500 leading industrialists from Europe, the United States of America, and Canada, with the object of analysing the new markets for equipment and materials, as well as the amount of investment necessary. The first volume of the Proceedings which has now been published, covers the sessions devoted to surveying the European nuclear programmes, their economics and finance, and two special E.N.E.A. studies, on "Estimates of Nuclear Energy Production in Europe, 1958–65," and "Financing Nuclear Energy Programmes and Relations between State and Industry" which were prepared for the Conference and have since been revised in the light of the conference findings.

Europe is now spending nearly 1000 million dollars annually on nuclear research and the first nuclear power installations, while construction programmes for power stations during the next six years represent an investment of some 3000 million dollars. The Conference agreed that the main purpose of these programmes will be the acquisition of knowledge, until nuclear electricity is able to compete economically with conventionally produced electricity. It was, however, recognised that nuclear power was indispensable for the future of Europe.

The full proceedings of the Stresa Conference are being published in four volumes, each priced at 18s. 6d. The remaining volumes deal, respectively, with atomic law and administration, the market for nuclear materials, and the market for nuclear equipment and instrumentation, and include the revised E.N.E.A. Conference studies on these subjects.

Introduction to Plasticity. By WILLIAM PRAGER. Addison-Wesley Publishing Company, Inc., 10–12, Chitty Street, London, W.1. Price 49s.

THE word "plasticity" has come to have two meanings, denoting both the mathematical and the engineering theory. Mathematical theory may be typified by, for example, its practical application to plastic metal-forming processes; engineering theory by the plastic design of steel frames. Both disciplines are based on similar foundations of applied mathematics and experimental research.

Professor Prager's book covers, very comfortably, both of the disciplines. He develops, in the first two chapters, methods which can be applied to examples drawn from mechanical and from civil engineering. An example of his attitude to the subject may perhaps be given by the following quotation from his discussion of the definition of load-carrying capacity: "The heated arguments in favour of one or the other manner of approach that are found in the literature seem futile." This comment is eminently fair; the art of the theory of plasticity is to make more or less realistic assumptions as to material properties, structural behaviour and so on, and not to be adept in the fine splitting of mathematical hairs. The quotation, in fact, betrays Professor Prager's dissatisfaction with mathematics unless it is relevant to engineering problems.

Another quotation, however, betrays Professor Prager's own preoccupation with the concept of plastic potential; speaking of the theory of statically determinate stress fields, he says: "Because it is mathematically attractive, it has been developed far beyond the limits of its practical usefulness." Now statically determinate boundary conditions can be matched with limiting stress fields without the use of a flow rule furnished by the plastic potential. It is perhaps untrue to say that the stress field theory has been developed too far; there are problems (for example in soil mechanics) for which it proves valuable to have a means for the exact calculation of stress fields corresponding to given boundary conditions. Such problems are cumbersome and would not fit easily into Professor Prager's presentation of the subject.

It is, in fact, Professor Prager's use of plastic potential which makes his book such a delight to read. The theory is developed at the end of the first chapter, and is introduced by a series of elegant models of plastic materials. The second chapter discusses the mechanical behaviour of plastic structures, and this behaviour is represented pictorially in what strictly may be called vector diagrams. But they are even more than vector diagrams; looking at one of Professor Prager's illustrations of stress space, the reader can almost immediately visualise the collapse mechanism of a given structure, or can convince himself that shakedown will occur under a given range of loading.

The third, and longest, chapter of the book, on "Limit Analysis and Design," deals with applications of plastic theory to a whole range of structures, including portal frames, arches, flat plates, cylindrical shells, and even voussoir arches. Again, in each example discussed, the pictorial representation of the behaviour is an immediate aid both to understanding the problem and to grasping the solution. The chapter ends with some examples of minimum weight design. The fourth and last chapter deals with problems of finite plastic deformation, and, after principles are established, examples are given of sheet extrusion, wedge indentation, tube drawing and so on.

A valuable part of the book is the set of examples given for the reader to work, in which important applications are apparent. The book itself is based on a series of lectures given in Zurich; they were published in Switzerland in 1955. It is evident that considerable rewriting has been done since then; later references are not simply added as footnotes, but are integrated into the text. There are no spare lines and there is no padding; Professor Prager has considered every word, and thought deeply on every aspect of plastic theory.

If a criticism of the presentation can be made, it is that, paradoxically, the material is too easy for the reader. Occasionally there are certain difficulties that Professor Prager does not mention, perhaps because the mathematical treatment of a problem does not fit his adopted simple pattern. In some places it is obvious that Professor Prager has had to use advanced mathematical techniques to arrive at a certain result; the result is presented without the reasoning, and is streamlined into the form chosen for the book. Small digressions might have been welcome; they would, if nothing else, have warned the reader against being over-confident.

But these are essentially trivial criticisms; the author is completely master of this, his main field of study, and he communicates this sense of mastery to the reader.

Books Received

Elementary Astronomy. By O. Struve, B. Lynds and H. Pillans. Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 55s.

Geology for Engineers. Second Edition. By J. M. Trefethen. D. Van Nostrand Company, Ltd., 358, Kensington High Street, London, W.14. Price 64s.

The Diesel Engine. By L. V. Armstrong and J. B. Hartman. The Macmillan Company, New York; 10, South Audley Street, London, W.1. Price 45s. 6d.

Reinforced Concrete Simply Explained. Fifth edition. By O. Faber. Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 12s. 6d.

Steelmaking for Steelmakers. By A. Jackson. The Publications Department, The United Steel Companies, Ltd., 17, Westbourne Road, Sheffield, 10. Price 40s.

The Design and Construction of High Pressure Chemical Plant. Second Edition. By H. Tongue. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 84s.

Engineering Law. Fifth Edition. By R. E. Laidlaw, C. R. Young and A. R. Dick. Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 56s.

History of the Grinding Machine. By R. S. Woodbury. The Technology Press, Massachusetts Institute of Technology, Cambridge 39, Massachusetts, U.S.A. Price 3.50 dollars.

Applied Mechanics, Vol. 2, Dynamics. By G. W. Housner and D. E. Hudson. D. Van Nostrand Company, Ltd., 358, Kensington High Street, London, W.14. Price 39s. 6d.

British Petroleum Equipment. 1959/60 edition. The Council of British Manufacturers of Petroleum Equipment, 2, Princes Row, Buckingham Palace Road, London, S.W.1. Price 50s.

JS-Tafel für Luft und Verbrennungagase. Second edition. By O. Lutz and F. Wolf. Springer-Verlag, Berlin-Wilmersdorf, Heidelberger Platz 3, Western Germany. Price, with Tables, DM.9.00.

Obituary

J. W. SANDFORD FAWCETT

WE have learned with regret of the death of Mr. John Weller Sandford Fawcett, which occurred suddenly at his home at Hampton Wick, on January 4. Mr. Fawcett, who was fifty-nine, was the senior partner in the consulting firm of Sandford Fawcett and Partners. He was educated at Radley and after working as a chemist on acid, fertiliser and sugar plants in India, trained as a civil engineer with John Taylor and Son.

Subsequently Mr. Fawcett served as resident engineer on the construction of sewage works at Folkestone, Winchester and Broadstairs. In 1933, he joined his father, who had lately retired from the position of chief engineer, Ministry of Health, in establishing the firm of Sandford Fawcett and Partners, and thereafter specialised in the design of water works and sewerage schemes. The treatment works for the Colne Valley Sewerage Board and for the St. Helens Corporation were among the many projects carried out under Mr. Fawcett's direction in recent years. Mr. Fawcett made several visits to the U.S.A. to investigate modern sewage treatment plants. He was a founder partner of Canadian-British Engineering Consultants, which was established in 1953, and he advised on several sewage treatment and water supply projects in Ontario, the Maritime Provinces and the Yukon. He was also a member of a consortium of consultants engaged on a feasibility study for a road and rail crossing of the Northumberland Strait to Prince Edward Island.

Mr. Fawcett was elected an Associate Member of the Institution of Civil Engineers in 1930 and a full Member in 1938. He was also a member of the Institution of Water Engineers and the Association of Consulting Engineers and a Fellow of the Geological Society. In addition, Mr. Fawcett frequently acted as an arbitrator in civil engineering matters; he was a member of the panel authorised by the Reservoir (Safety Provision) Act, 1930, to design, construct and inspect reservoirs.

ARTHUR MONK

WE record with regret the death of Mr. Arthur Monk, chairman and joint managing director of A. Monk and Co., Ltd., which occurred suddenly last Saturday, January 9. Mr. Monk, who was sixty-seven, founded the building and civil engineering firm which bears his name as a small private construction firm, in 1920, at Irlam. Since then the company has become one of this country's large contracting firms employing several thousand people and being responsible for many important industrial projects.

Mr. Monk, who was a member of the Institution of Structural Engineers, was keenly interested in local government affairs and had been for many years a Lancashire County Councillor. He was equally interested in national politics and had served for a number of years as chairman of the Newton Division Conservative Association. Furthermore, Mr. Monk gave generous support to numerous good causes. He had recently made a donation of £10,000 to the Manchester College of Technology, where he had received his early training.

330kV Oil-Filled Cables for Kariba

WE have received some details of the 330kV oil-filled cables made by British Insulated Callender's Cables, Ltd., Norfolk House, Norfolk Street, London, W.C.2, for the Kariba hydro-electric scheme of the Federal Power Board of Rhodesia and Nyasaland.

The design of these cables was determined largely by the unusual route conditions. From the terminals of the transformers, situated in an underground transformer hall in the power station, the cables are laid in sand-filled troughs through a horizontal tunnel for approximately 240ft before rising up a 540ft vertical shaft. At the surface the remainder of the route is in steeply rising ground ending at a switch yard. This latter section is laid in concrete chases on the surface. Three groups of three cables are supported on cleats in the shaft, together with one spare cable per group. The longest individual length of cable installed is 650 yards and the shortest 572 yards.

The specified cable current is 500A at 330kV (equivalent to 285MVA for a three-phase group) which has necessitated a conductor area of 0·85 square inch of copper. As can be deduced from the stepped sample illustrated here a central spiral steel duct surrounded by layers of high conductivity copper wires of the required section is used for the conductor. The conductor is lapped with three metallised paper screening tapes, followed by graded thickness insulating paper tapes to a wall thickness of approximately 1·1in radial. The dielectric is finally screened by one metallised paper and one copper woven fabric tape. A lead alloy sheath reinforced with tin-bronze tapes and armoured with hard drawn aluminium wires protects the dielectric and forms the pressure-retaining wall of the cable. The impervious corrosion resistant and other lappings are listed below the first illustration.

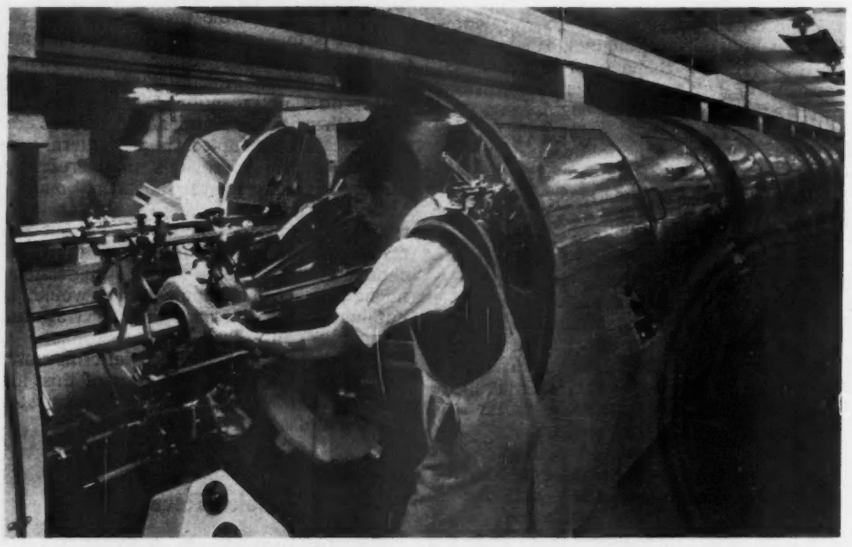
A major operation during the manufacture of the cables was the application of the insulating papers, which were built up to a radial thickness well outside the range met on cables previously supplied. Stringent standards of uniformity and performance were established for the cables and close quality control was exercised at all stages. The whole insulating process was carried out in a sealed enclosure (illustrated here) in which the temperature and relative humidity of the air were closely controlled to give precise uniformity to the finished dielectric. These precautions resulted in a dielectric free from irregularities.

The hydraulic design of the cable and the methods of jointing adopted were unusual because of the high hydrostatic pressure (250 lb–300 lb per square inch) at the bottom of the shaft. For jointing the sealing end at the bottom of the shaft the cable was drained of impregnating oil and jointing was completed on the drained cable. The cable was then re-impregnated on site and tests showed that the impregnation was not inferior to that obtained during its original manufacture. Full-scale laboratory and field trials were carried out on prototype cables of the full contract length to prove the soundness of the technique before the method was adopted for commercial installation.

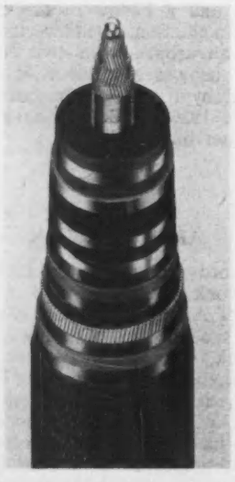
The cables are run in one continuous length between terminals, no accessories other than sealing ends being required for the contract. However, a straight joint was developed and tested for maintenance purposes. The sealing ends are condenser cone bushings having hand-applied paper rolls housed in outdoor porcelains. They are the same at each end of the cable route. The outdoor type termination used in the transformer hall was dictated by the provision and connection of surge arrestors at the transformer terminals. A characteristic of the condenser cone is that the build-up of paper rolls and foils is capable of withstanding the full hydrostatic pressure in the event of the porcelain being accidentally damaged.

Tests

Because Kariba is in an area of very severe lightning incidence an impulse test withstand

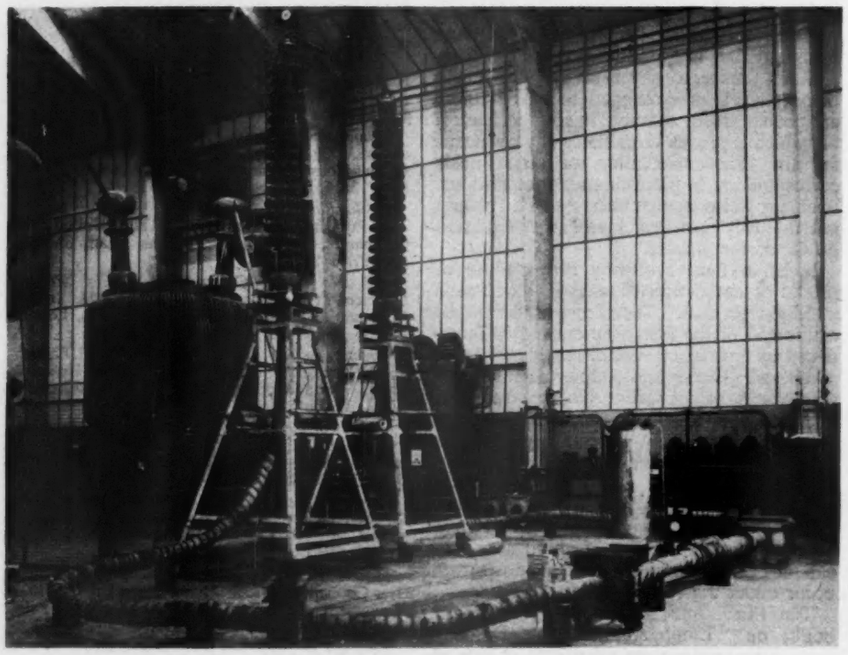


Setting-up for precision lapping with paper dielectric in an air conditioned enclosure



The build-up of the cable from the centre outwards is as follows:
Central oil duct of spiral steel.
Four layers of high conductivity copper wire.
Three lapped screening tapes of metallised paper.
Insulating paper tapes of graded thickness.
One lapped screening of metallised paper.
One lapped screening of copper woven fabric tape.
Lead alloy sheath.
Proofed cotton bedding tapes.
Tinned bronze reinforcement tape between rubber separators.
Tinned bronze reinforcement tape.
P.v.c. tape.
Two lapped rubber tapes.
P.v.c. tape.
Bitumen-impregnated hessian tape.
Hand-drawn aluminium wire armouring.
P.v.c. tape.
Two lapped rubber tapes.
P.v.c. tapes.
Two lappings of impregnated hessian with graphite finish.

Stepped sample of 330kV oil-filled cable for Kariba hydro-electric scheme



Cable and accessories for Kariba hydro-electric scheme undergoing loading cycle tests in the B.I.C.C. high-voltage laboratory

level of 1500kV on the cables and accessories was specified as part of the exacting series of type acceptance tests to be applied. Most of the tests were done on installations consisting of two porcelains, a straight joint and approximately 30 yards of drained and re-impregnated cable as illustrated. The tests consisted of an a.c. voltage test of 475kV r.m.s. for fifteen minutes, two series of twenty loading cycles at 1½ times the nominal working voltage, during which the cable was heated for a period of eight hours to a conductor temperature of 85 deg. Cent. and allowed to cool for twenty-four hours, and an impulse withstand test of 1500kV peak consisting of ten positive followed by ten negative impulses at maximum conductor temperature. After the impulse withstand test, further impulses were applied until eventually a cable failure occurred at a peak voltage of 1720kV.

In addition, the following type tests were done on the cable only: power factor/voltage test, power factor/temperature test, bending test, internal oil pressure test at 375 lb per square inch for seven days and dielectric thermal resistance test. The following type approval tests were done on the sealing ends only: wet a.c. voltage withstand, dry a.c. voltage withstand, temperature rise, temperature cycle and porosity test on porcelain. All the tests were completed satisfactorily in accordance with the appropriate specifications.

Before despatch all lengths of cable manufactured were routine tested at the factory at a voltage of 380kV r.m.s. between conductor and sheath for fifteen minutes. Power factors were also measured at voltages up to twice the nominal working voltage.

Installation

The cable drums (15ft diameter) were shipped to Beira, Portuguese East Africa, and transported 600 miles by road to Kariba. From the switch station above the south bank, the cable was pulled off the drum by hand for a short distance and then hauled the 200 yards to the cable shaft entrance by a 2-ton hand winch. Lowering of the cable at a controlled rate down the shaft itself and into the tunnel at the bottom was done by using a 10-ton power-driven winch, the winch rope being attached to the cable at 20ft intervals by temporary wooden cleats. At the foot of the shaft, the cleats were removed and the cable was drawn into the underground concrete chase by a winch near the terminal position in the transformer hall.

In the vertical shaft the cables are permanently supported by cleats in wave formation to limit the strain due to thermal movement to a safe level.

The first cable of circuit "A" was installed in August, 1959, and the complete circuit underwent commissioning trials in November before starting commercial operation in January, 1960.

The order for the 330kV cables (and for auxiliary 11kV and control cables), was placed in 1956 with British Insulated Callender's Cables, Ltd., through Messrs. Merz and McLellan, the consultants for the electrical and mechanical engineering aspects of the Kariba scheme.

Tunnel Diodes

Development of semiconductor tunnel diodes by the transistor division of Standard Telephones and Cables, Ltd., Footscray, Kent, has reached an advanced stage, and the company has decided to make samples available so that circuit designers can become familiar with their properties. The tunnel diode exhibits a negative resistance region in the forward characteristic which enables it to act as an oscillator if connected across a tuned circuit. Its major interest therefore appears to be as a microwave oscillator for frequencies up to 10,000 Mc/s. At present it is suitable only for very low powers, and applications are being considered in computer circuits or as a mixer in u.h.f. and v.h.f. receivers. These devices are believed to be the first of their kind in Europe. Samples are available and are the forerunners of a range with a performance extending into the v.h.f. range.

[Reply Card No. E991]

Lisbon Underground Railway

THE first section of the Lisbon "Metropolitano" underground railway was opened by the President of the Portuguese Republic on December 29 last. This scheme for an underground railway system in Lisbon was sanctioned in 1953. Work is being undertaken in three stages, the first being the section from Restauradores to Sete Rios and Entre Campos as seen in Fig. 1. It was announced at the opening ceremony that work would now continue as rapidly as possible with Stage 2, consisting of the extension from Restauradores to Rossio and on to Alvalade. Stage 3 will comprise the sections running east and west of Rossio along the Tagus. A further line, from Conde Barao to Barbadinhos, is shown on the map, but this is a long-term project outside the present programme.

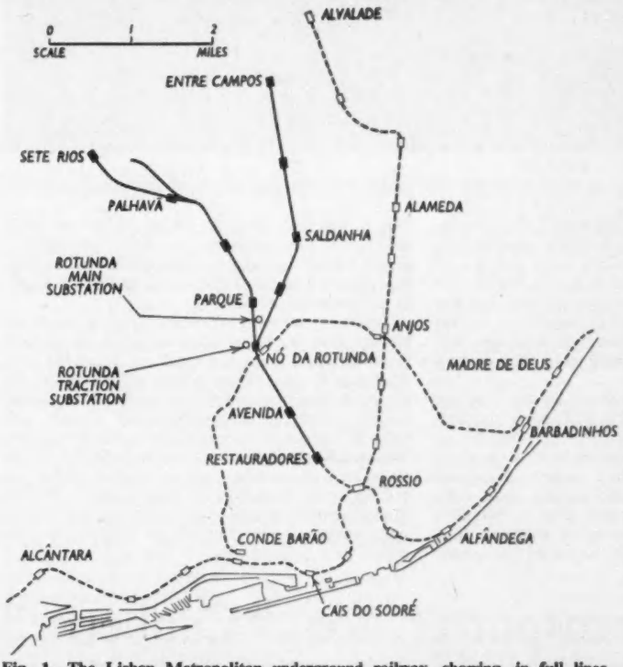


Fig. 1—The Lisbon Metropolitan underground railway, showing, in full lines, sections now open, and future extensions dotted

Most of the section just completed, some 4½ miles in length, has been built on the cut-and-cover system, but tunnelling was necessary between Nó da Rotunda and Parque, where the line passes under one of the city parks. The station at Nó da Rotunda is at a lower level than the others and the platforms here are reached by escalators.

Trains are formed at present of two motor coaches, but they will be lengthened later to four-car sets with Scharfenberg automatic couplers. The electrical equipment of the twenty-four motor coaches now in service was supplied by Siemens-Schuckertwerke A.G. Maximum speed is 62 m.p.h., but trains are at present restricted to 37 m.p.h. and make the journey at an overall average speed of 18 m.p.h., including twenty-second station stops. Power is taken from a third rail at 750V d.c. and each motor coach is equipped with two 120 h.p., 1170 r.p.m. motors operated under series/parallel control with twenty-four notches. Rheostatic braking is used normally at speeds down to 6 m.p.h., the air brake being applied only at lower speeds or in emergency. The air brake is supplemented by four magnetic track brakes on each coach capable of an equalised pressure of 6400 kg, enabling a train to be brought to a stand within the prescribed braking distance on a gradient of 1 in 25. For rheostatic braking the traction motor fields are separately-excited by a 750V/110V, 13·5kW, motor-generator set in each coach which also charges the battery and supplies the auxiliary services. Microphone and loudspeaker equipment supplied by Siemens and Halske A.G., is installed for guards' announcements of stopping places.

Contracts for the first stage of the scheme covering the power supply, ventilating and pumping equipment, and also the high-tension cabling from the Rotunda main substation and Rotunda traction substation were placed with The General Electric Company, Ltd., and were the only ones awarded to a British manufacturer for the part of the project now completed. The G.E.C. plant was commissioned in June, 1959.

Power is supplied from the grid at 10kV, three-phase, 50 c/s through two feeders to a seven-panel board in the Rotunda main substation. Two 10kV cables leave this board to terminate at an isolator board in the underground traction substation where two twin-cylinder rectifier equipments, each rated at 1500kW, are installed for the 750V d.c. traction supply.

An eleven-panel 3kV board in the main substation is fed through a 10/3kV, 1000kVA transformer and controls the supply to the six power and lighting feeders serving the 3kV distribution points at the passenger stations. An 850kVA, 3kV diesel-alternator set with Davey Paxman 12YLX is installed which can supply limited power to the system in the event of a 10kV power failure.

The local 380V/220V supply at the main substation is taken from a three-cubicle switchboard which is supplied by two 120kVA transformers energised from the 10kV and 3kV boards respectively. A standby low-voltage feeder from the city supply also feeds this board but interlocks prevent the public supply from being paralleled with the low-voltage side of the 120kVA transformers. All the main 3kV and 10kV switchgear, the high-speed track feeder circuit breakers and the standby diesel-alternator set are remotely controlled from the main control board in the Rotunda main substation (Fig. 2). Circuit breakers are operated by combined control switches and semaphore indicators, with discrepancy lamps, on the mimic diagrams. In the 10kV diagram additional electrically-operated semaphores show whether a circuit breaker is plugged into the front or rear busbars, or is isolated. Operation of protective relays is signalled by "check alarm" relays which cause an audible warning to be given and an "accept" lamp to light. The warning is acknowledged by pressing the lamp cap, which silences the alarm but leaves the lamp alight until the relay has been reset.

The ventilation is in two parts; main ventilation of the stations and tunnels, and independent ventilation of the electrical substation.

The main ventilation is provided partly by forced-draught fresh air and partly by air drawn in through the station entrances as a result of extraction from the tunnels. At each station a fresh air supply of 17,000 cubic feet per minute is provided by a Woods 48in "Aerofoil" two-stage contra-rotating fan. The air is ducted from the fan to outlets situated in the wall at the back of the platform and under the edge of the platform.

Air is exhausted in the tunnels at five points approximately midway between the stations.

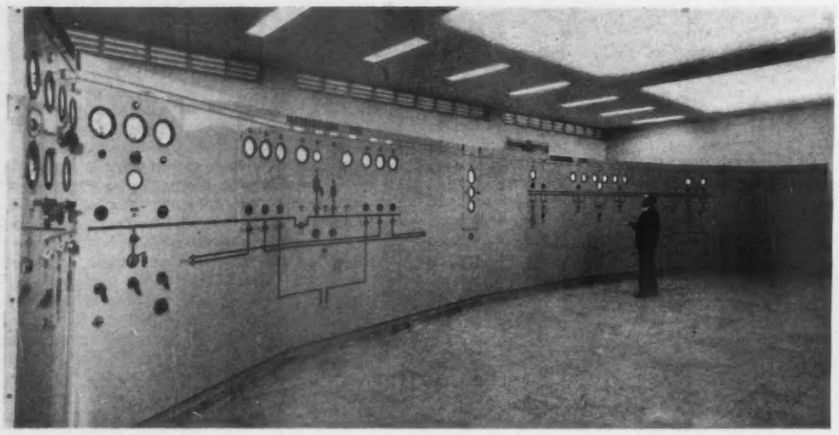


Fig. 2—Remote control board at main substation with mimic diagrams and semaphore discrepancy switches

At each there is a 48in "Aerofoil" single-stage fan driven by a two-speed motor running at either 980 or 725 r.p.m. The total volume of air extracted from the tunnels at the higher fan speed is 135,000 cubic feet per minute and the total forced-draught fresh air supply is 51,000 cubic feet per minute. The high and low rate of extraction can be regulated from each station by remote control.

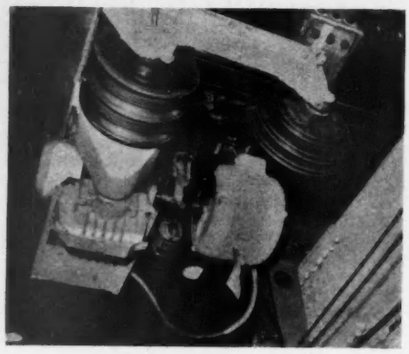
The rectifiers for the railway in the traction substation are cooled by forced air supply through grills in the floor at four different rates of air flow, from 26,000 to 4400 cubic feet per minute, under thermostatic control which maintains constant temperature under varying load conditions. The air supply is provided by two 38in "Aerofoil" fans with two-speed motors. The transformers are cooled by another two-speed 38in "Aerofoil" fan delivering 10,000 or 7600 cubic feet per minute. A 48in "Aerofoil" single stage fan exhausting 31,800 cubic feet per minute ventilates the diesel-alternator room at the main substation.

Thirteen pumping stations, with a total of twenty pumps, have been supplied to extract water drained from the track and stations and discharge it into sumps to prevent flooding. All the pumps are controlled through fixed electrodes in the sumps; operations and alarms are signalled direct to panels in the railway stations. Water drained from platforms and tracks usually contains some solids, such as stones, cinders or refuse, and therefore "Non-Clogg" pumps manufactured by Lee, Howl and Co., Ltd., have been supplied, the smallest of which will pass solids with a diameter of 4·5cm.

Cargo Transporter for "Canberra"

IN our issue of November 20, 1959, we gave a general report on the state of construction of the P. & O. liner "Canberra" on the berth at the Belfast yard of Harland and Wolff, Ltd. One of the particular innovations introduced into the design of the ship is the side loading device which eliminates the need for trunked hatchways, with their disturbance of the accommodation layout, and the need to mount derricks and winches. Apart from making more passenger space available, the adoption of this gear improves the efficiency of cargo handling and enables operations to continue in adverse weather. Furthermore, since the equipment is housed within the hull of the ship when at sea, it does not suffer the same degree of deterioration as that of more conventional equipment which is exposed to the elements.

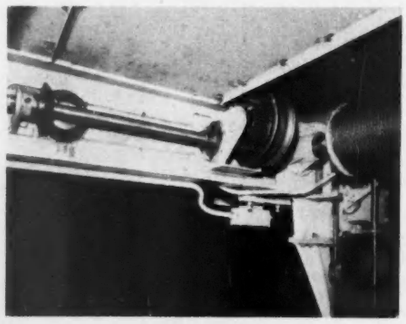
The Carron Company has been closely concerned with the design and development of the cargo transporter and we recently paid a visit to the company's works at Falkirk to witness a demonstration of the first of the units to be completed. Our illustration shows the equipment with the boom fully extended and with the carriage and its loaded platform traversed to the end of its travel. The transporter consists of a boom about 90ft long which is built of two 20in by 6½in "H" beams having spacers placed at 5ft 6in intervals along their length. Underneath the bottom flange of the beams is welded a rail of square section which runs in a groove in the support and guide rollers which carry the boom. These rollers are supported on pillars, built of two channels welded toe to toe, or on deck head brackets where there are no pillars. From the inboard position the boom is traversed through openings in the ship's side to extend 30ft beyond the side of the ship or 32ft beyond the last support. A single winch operates the boom at a speed of 25ft per minute, and is powered by



Boom winch

a 5 h.p. Bruce Peebles motor running at 860 r.p.m. and driving twin spools at 8·5 r.p.m. through worm and spur reduction gearing. Movement of the boom is by means of two continuous lengths of wire rope, which are anchored to the end spacers of the boom and have several turns laid on the spools, as illustrated by the photograph reproduced herewith.

Set inside the line of the boom girders and bolted to the underside of the structure are two 9in by 4in "H" sections which serve as a track for the rollers taking the moving platform. That intended for transporting cars is constructed of light alloy and measures 19ft by 7ft 6in and weighs 13 cwt, which together with



Carriage traversing gear

the load makes the total weight to be lifted 3 tons. There is also a smaller size platform having a wooden deck for cargo handling. The platform hoisting gear consists of four winch drums, mounted two on each side, each pair driven through worm reduction gearing which transmits the power from a double-ended 16 h.p. Bruce Peebles motor running at 860 r.p.m. The car platform, using double purchase, has a hoisting speed of 60ft per minute while the cargo platform has double that speed using single purchase. For traversing there is a 5 h.p., 860 r.p.m. A.E.I. motor driving a cross shaft through bevel gears and two spools through spur reduction gearing, as can be seen in our illustration. The spools are driven at 44 r.p.m. and through the medium of two lengths of wire rope, shackled to each end of the boom, impart a traversing speed of 125ft per minute to the carriage. An operator, accommodated in a cab fitted to one side of the carriage, controls the hoisting and traversing movements while limit switches at various points prevent overrun of the boom, carriage or platform.

The total weight of the equipment is 15 tons.

Transporter shown with boom extended and carriage at end of travel

SHORTER REPORTS

General Conditions for Export Contracts

A NEW Model Form of General Conditions of Contract, known as "B2 (1960): Export Contracts, Delivery F.O.B., C.I.F., or F.O.R., with Supervision of Erection," has been prepared by the Joint Committee on Model Forms of General Conditions of Contract of the Institution of Mechanical Engineers and the Institution of Electrical Engineers, and published under the authority of the councils of these two Institutions. Following an approach in 1952 by the Association of Consulting Engineers, it was agreed that this Association should adopt and recommend to its members the use of this model form of general conditions of contract and the name of the Association accordingly appears on the title page of the document.

This new Model Form now takes the place of the I.E.E. Model Form B2 (1928) (which has been withdrawn) for export contracts which include delivery and supervision of erection of electrical plant. Likewise, for export contracts including delivery and complete erection, Model Form B2 (1928) has been superseded by Model Form B3 (1954).

Thus, the complete range of Model Forms issued jointly by the two Institutions is as follows :—

"B1 (1956) Export Contracts, Delivery F.O.B. or C.I.F." Price 4s. 6d.
"B2 (1960) Export Contracts, Delivery F.O.B., C.I.F., or F.O.R., with Supervision of Erection." Price 4s. 6d.
"B3 (1954) Export Contracts, including Delivery to and Erection on Site of Electrical and Mechanical Plant." Price 5s.

Copies of these publications can be obtained from the Secretary of the Institution of Mechanical Engineers, 1, Birdcage Walk, London, S.W.1, or the Secretary of the Institution of Electrical Engineers, Savoy Place, London, W.C.2, at the prices quoted, which include postage.

Hirfanli Hydro-Electric Scheme

ON January 8, the Prime Minister of the Turkish Republic, Mr. Menderes, inaugurated a hydro-electric scheme at Hirfanli in Anatolia. The scheme utilises a site on the Kizilmirmak river, which is the largest river in Turkey, and it has an installed capacity of 110MW in three similar sets. It has been built by two British contracting organisations, namely, George Wimpey and Co., Ltd., and The English Electric Company, Ltd., to the designs of American consultants, Messrs. Tippetts-Abbett-McCarthy-Stratton, in consultation with engineers of the Turkish State Water Board.

The scheme is characterised by a large rock-fill dam, which has formed a reservoir which extends 46 miles upstream, and is intended to provide storage at the head of a chain of four further stations to be built downstream, both for power and irrigation. The power output of the completed chain of developments will be about 1500 million units annually.

The rock-fill dam is a typical example of U.S. design of this class of structure. The impervious core, which is of clay, is sloping, the grouted cut-off being positioned under about the middle of the upstream face, and the core extending from it, upwards and back to the crest. The core is backed by a central region of fine weathered rock, with a rock filter on its downstream side. The dam has a height of 85m, from stream bed to crest, and a length of 366m, and it contains about 2,000,000 cubic metres of graded materials.

Thin diversion tunnels with a lined diameter of 8m were built over a length of about 500m to allow construction of the dam. These two tunnels were then modified—by constructing a power intake, plugging their upstream ends, and connecting with four steel-lined penstock tunnels and a compensation water culvert at the downstream—to serve the power house, which is built on the right bank close to the dam. A spill weir, with a channel running back to the river, has been constructed at a saddle on the right bank side.

The structural works have been designed to withstand what are called "secondary earthquakes," and 120 m.p.h. winds. The power house has thus been built without windows. The scheme cost £23,000,000.

Generating Plant Installed by the C.E.G.B. in 1959

NEW generating plant, with a total output capacity of 1670MW, was installed by the Central Electricity Generating Board in 1959. As shown in the accompanying table this new plant was installed in fifteen power stations (five of them new) owned by the C.E.G.B. in England and Wales. The new installations consisted of twenty-one turbo-generators with a total installed capacity of 1775MW and twenty-three boilers with a total evaporative capacity of 14,700,000 lb of steam per hour.

The generating sets installed included the first of a number of 200MW sets planned for commissioning in the next few years: this set (THE ENGINEER, Vol. 201, 1956, page 662) the largest unit yet installed by the C.E.G.B. has a greater output capacity than any other unit operating in Western Europe. The associated boiler has an evaporative capacity of 1,400,000 lb of steam per hour and the turbine stop valve conditions are 2300 lb per square inch at 1050 deg. Fah, with reheat to 1000 deg. Fah. between the h.p. and l.p. cylinders.

Second 550MW Set for Thorpe Marsh Power Station

THE second 550MW turbine-generator for installation in the Central Electricity Generating Board's Thorpe Marsh power station, under construction near Doncaster, Yorkshire, is to be ordered from Associated Electrical Industries, Ltd. It will be the largest two-speed conventional cross-compound machine generating at 50 c/s. The total value of the contract will be about £3,750,000, and the machine will be designed and manufactured at the Trafford Park works of the A.E.I. turbine-generator division. The unit is expected to operate with an overall station efficiency 7 per cent better than the most efficient station listed in the C.E.G.B.'s annual report for 1958–59, Castle Donington, where six A.E.I. turbine-generators are installed, and 35 per cent better than the average of all C.E.G.B. stations listed in the report.

The 550MW turbine-generator will consist of a multi-cylinder steam turbine, divided into two sections on two separate lines, each driving a 275MW a.c., 50 c/s generator. The two sections of the turbine will be cross compounded with a single-flow high-pressure cylinder and a double-flow first intermediate-pressure cylinder on one line, running at 3000 r.p.m., and two single-flow second intermediate-pressure and two double-flow low-pressure cylinders on the other line, running at 1500 r.p.m.

Steam at 2300 lb per square inch gauge and 1050 deg. Fah. will be expanded through the h.p. cylinder, and reheated to 1050 deg. Fah. before expanding through the first i.p. cylinder. From the high-speed line, the steam will pass over to twin second i.p. cylinders on the low-speed line, and thence to the l.p. cylinders, before exhausting to the condensers.

The two generators, although of equal output, will differ in size because one will run at 3000 r.p.m. and the other at 1500 r.p.m., but both will have stator windings cooled by water circulated through the conductors (in the form of thick-walled copper tubes of rectangular cross-

C.E.G.B. Generating Plant Commissioned in 1959

Power station	C.E.G.B. project group	Turbo-generator plant		Boiler plant		Main high-pressure pipework
		Installed capacity, MW	Maker	Capacity, lb per hour	Maker	Maker
†Agecroft "C"	Northern	1×120	A.E.I.	1×860,000	International Combustion	Stewarts and Lloyds
*Belvedere L.P.	Southern	3×60	English Electric	3×550,000	John Brown	Aiton
Blyth "A"	Northern	2×120	A.E.I.	2×860,000	Babcock and Wilcox	Babcock and Wilcox
Bold "B"	Northern	1×60	G.E.C.	1×550,000	John Thompson	John Thompson
Castle Donington	Midlands	1×100	A.E.I.	1×830,000	Babcock and Wilcox	Aiton
*Drakelow "B"	Midlands	2×120	Parsons	2×860,000	International Combustion / Foster-Wheeler	Stewarts and Lloyds
*Elland	Northern	2×60	A.E.I.	2×550,000	Yarrow/John Brown	Stewarts and Lloyds/ John Thompson
Ferrybridge "B"	Northern	1×100	Parsons	1×760,000	Babcock and Wilcox	Stewarts and Lloyds
*High Marnham	Midlands/Northern	1×200	English Electric	1×1,400,000	International Combustion	Aiton
*Little Barford "B"	Southern	2×60	Parsons	2×550,000	Foster-Wheeler	Stewarts and Lloyds
Marchwood	Southern	1×60	English Electric	1×550,000	John Thompson	Stewarts and Lloyds
Portishead "B"	Southern	1×65	A.E.I.	3×300,000	Mitchell Engineering	Stewarts and Lloyds
South Denes	Southern	1×60	Richardsons Westgarth	1×550,000	Mitchell Engineering	John Thompson
†Spondon "H"	Midlands	1×10	A.E.I.	1×180,000	Foster-Wheeler	Aiton
Willington "A"	Midlands	1×100	English Electric	1×830,000	International Combustion	Aiton
Fifteen stations including five new stations and two new sections		Twenty-one turbo-generators, total installed capacity 1775MW		Twenty-three boilers, total installed capacity 14,700,000 lb per hour		

The plants listed, complete with all ancillary equipment, have been commissioned during the twelve months of the year 1959.

In addition to the above, the following boilers have been completed but commissioning awaits availability of associated turbo-generators :—Northfleet, boiler No. 1, 860,000 lb per hour capacity, made by Foster-Wheeler; South Denes, boiler No. 4, 550,000 lb per hour capacity, made by Mitchell Engineering; Spondon "H." boiler No. 24, 180,000 lb per hour capacity, made by Foster-Wheeler, completed but not put on the steam range.

* New stations in which plant has been commissioned for the first time in 1959. † New sections of power stations.

SHORTER REPORTS *(Continued)*

section). The other parts of the generators will be cooled by hydrogen circulated at a pressure of 30 lb per square inch gauge inside the sealed casings of the generators by fans mounted on the ends of the rotors. The gas will be blown through the rotor, where it will be in direct contact with the copper of the windings and through ducts in the stator core. The hydrogen will be cooled before recirculation by banks of water-cooled tubes in the generator casing.

London–Yorkshire Motorway

THE MINISTER OF TRANSPORT has published a draft scheme for the second part of the London–Yorkshire motorway. The proposed route of this new 86-mile extension of M.1 runs roughly northwards from Crick, near Rugby, through Northamptonshire, Leicestershire, Derbyshire and Nottinghamshire and ends in the West Riding of Yorkshire at a junction with the Doncaster by-pass motorway.

Through Leicestershire the route follows the "compromise" line proposed by the Leicestershire County Council as an alternative to two earlier proposals which met with strong objections on agricultural and amenity grounds, and which consequently delayed the construction of this section of the M.1 route. The draft scheme and plan showing the proposed line will be open to inspection for the next three months at the offices of various local authorities in areas through which the route passes. During that time any person may make representations to the Minister or lodge objections. Proposals for an extension of the motorway in the West Riding towards Sheffield and Leeds, and for a spur from Catthorpe in Leicestershire to join ultimately with a Birmingham to Lancaster motorway, are soon to be published.

New Ranges of Totally-Enclosed Fan-Cooled Motors

NEW ranges of totally-enclosed fan-cooled electric motors with class-E insulation have been introduced by three British manufacturers. They comply with the appropriate British Standard, B.S. 2613 : 1957. By taking advantage of the increased temperature rise of 65 deg. Cent. permissible with class-E insulation, compared with the rise of 55 deg. Cent. applicable to class-A insulation, the new machines yield greater outputs than their predecessors, for a given frame size.

A.E.I., LTD.

The new motors announced by the motor and control gear division of Associated Electrical Industries, Ltd., Rugby, are designated Type KN-D. At present they are offered in sizes up to 7½ h.p., but later it is proposed to extend the range to 40 h.p. at 1500 r.p.m. (synchronous speed). The dimensions are such that any machine for a given rating is fully interchangeable with the corresponding ventilated motor (Type KN-C) built with British Standard dimensions in accordance with B.S. 2960 : 1958.

[Reply Card No. E1022A]

CROMPTON PARKINSON, LTD.

The new range of motors produced by Crompton Parkinson, Ltd., Crown House, Aldwych, London, W.C.2, is designated Series 5T.E.F.C. Dimensionally they are designed to conform to a new B.S. draft specification and their fixing dimensions are the same as those of the Series 5 ventilated motors of corresponding rating in accordance with B.S. 2960 : 1958.

The new Crompton Parkinson machines develop up to twice the horsepower of the company's previous machines of equivalent frame size. Besides being substantially smaller and lighter, for a given output the new machines cost about 9½ per cent less than the machines they supersede. Furthermore, the new motors can be supplied with fixing dimensions to the American N.E.M.A. specification and are, therefore, interchangeable with American machines of the same power.

Special attention has been paid to cooling. The fan is designed to promote an air stream which, as demonstrated by smoke tests, is in close contact with the motor carcase over the whole of its length. Effective transfer of heat from the centre to the outside of the motor is effected by arranging that the rotor stamping packs should be an interference fit in their housings. At present the motors are available in ratings ranging from 1 h.p. to 7½ h.p. at 1400 r.p.m. and the range is to be extended in a few months to 40 h.p. at 1400 r.p.m.

For special applications, high-torque rotors or high-slip rotors are available.

[Reply Card No. E1022B]

ENGLISH ELECTRIC COMPANY, LTD.

The new motors offered by The English Electric Company, Ltd., Marconi House, Strand, London, W.C.2, are designated Type D. They are dimensionally interchangeable with the company's C-type ventilated motors (conforming to B.S. 2960 : 1958). In addition, they have outputs up to 100 per cent greater than the company's existing type-B motors. However, for customers' convenience, the latter will still continue to be manufactured.

The new motors have a cast iron shell with "finger-proof" cowls, a non-corrosive (polyester) external fan, a terminal box of weatherproof construction, with four screw fixing bolts, drain holes with easily detachable plastics plugs, and a rating plate with details of the motor, including size of bearings and grade of grease.

In their standard form the new motors will give an average starting torque of about 200 per cent full load torque with an average starting current of about 700 per cent full-load current when started direct-on-line.

The full range of outputs, covered by twelve frame sizes, will be : two-pole, 1½–30 h.p. ; four-pole, 1–40 h.p. ; six-pole, ½–20 h.p. ; and eight-pole, ½–20 h.p. Production of foot-mounted motors up to 10 h.p. has already been started. Other outputs and mountings (foot, flange, skirt, foot and flange, pad and airstream rated) will follow.

[Reply Card No. E1022C]

Subscriber Trunk Dialling at Evesham

A FORM of group routing and charging equipment (GRACE) suitable for the smaller exchanges with subscriber trunk dialling has been developed by the Post Office in conjunction with The General Electric Company, Ltd., and was brought into operation in the 1300-line exchange at Evesham on January 6. This equipment is electromechanical and represents one of the three techniques pursued in the development of GRACE, namely electromechanical, electronic (with cold-cathode tubes), and magnetic drum. It was the electronic version which was used to provide the Bristol service in 1958, and the same form will be installed at a number of other large centres. The magnetic drum apparatus is at present only suitable for the very large centres such as London and Birmingham.

The electromechanical GRACE uses the well-tried techniques of automatic telephone switching, relays and uniselectors being employed to mark, hunt, switch, store information and to pulse-out charging and routing information to other automatic equipment used in the setting up of trunk calls. As in the electronic system described in our March 27, 1959, issue, the registers and translators are made as separate units, one translator being able to provide charging rate information and routing digits for a number of registers. A similar electromechanical installation was inaugurated at Bodmin on November 25 last year, so that Evesham is the third exchange in the country to have subscriber trunk dialling. Between now and March, 1962, it is planned to introduce this facility at over 300 exchanges in the United Kingdom.

Engine Honoured

THE new Ferodo Gold Trophy (the original trophy was given outright to Mr. G. A. Vandervell when he won it for the third time last year) has been awarded this year to Coventry Climax Engines, Ltd., builders of the engines used in the Formula I Cooper cars that won the World Manufacturers' Championship and with which the World Drivers' Championship was achieved by Jack Brabham. The engine used is a classical design, a light-alloy wet liner in-line four, of 94mm by 89·9mm ; on a compression ratio of 12, it develops 239 b.h.p. at 6750 r.p.m. and 210 lb per square inch brake mean effective pressure at 5000 r.p.m. Practically nothing except the twin-camshaft cylinder-head is derived from the original twin-bank, four-cam, 2½ litre ; the very great increase in swept volume that has been effected has entailed the use of G.E.C. tungsten alloy to form high-density balance masses, laminated metal-sealing rings for each of the closely-pitched cylinder liners, and bracing of the crankcase by steel studs extending horizontally (eight to each side) from the five main bearing caps. The engine was illustrated, installed in a Cooper, on page 504, October 30, 1959.

Hobart Bridge, Tasmania

THE Tasmanian Government has recently awarded a contract for the construction of a prestressed concrete road bridge over the River Derwent at Hobart, Tasmania, to two British civil engineering companies, Reed and Mallik, Ltd., and Braithwaite and Co., Engineers, Ltd. The value of the contract is in the region of £A4,250,000. The bridge was designed by Messrs. G. Maunsell and Partners.

It is to be sited immediately south of the existing floating arch bridge which it is to replace. The period of the contract will be three years and work is expected to start early this year. The bridge to be constructed is a multi-span structure in reinforced and prestressed concrete, 3364ft long between main abutments, with approach spans totalling 425ft on the west side and 840ft on the east side. The carriageway is 44ft wide flanked by two 4ft 6in footways.

The main navigation span is 310ft long and gives a clear height of 150ft above water level over a width of 180ft. This span is made up of a suspended section supported on cantilevers which extend from the adjacent 197ft navigation spans. The remainder of the bridge between the abutments is composed of 140ft spans, there being thirteen on the west side and six on the east side of the navigation spans. Expansion joints are provided on either side of the three navigation spans : at all other bridge supports the spans are continuous as far as the main abutments. The bridge deck consists of six precast prestressed concrete beams with an *in situ* reinforced concrete slab. *In situ* reinforced concrete diaphragms are provided at the supports which are slender concrete columns mounted on *cast-in-situ* piers with precast concrete skirting at water level. Each pier is supported on a group of vertical and raking bored piles of reinforced concrete, 4ft 6in diameter, which are to penetrate the alluvial deposits on the river bed down to the underlying rock stratum. The maximum depth of water in the estuary is approximately 120ft.

The main western abutment is in shallow water and is a massive reinforced concrete structure founded on rock. To the west of this abutment the approaches comprise a number of comparatively short spans in precast and prestressed concrete on reinforced concrete piers founded on rock, arranged to form a series of flyover crossings. The eastern abutment is a similar massive concrete structure but is located on the river bank where rock occurs at a shallow depth. The eastern approaches comprise twelve spans each 70ft in length, in reinforced and prestressed concrete, supporting a carriageway and footpaths.

Overhead Materials Handling in a Wire Works

A NEW factory which has been erected at Ecclesfield, near Sheffield, for Arthur Lee and Sons, Ltd., wire manufacturers, incorporates an overhead materials handling system which takes full advantage of the design characteristics of the building. When this factory was being designed it was decided to install a materials handling system of British MonoRail, Ltd., Brighouse, Yorks, as the most suitable method of dealing with the movement operations involved in production as this system fitted very well in a portal frame structure designed on plastic theory.

A portal frame construction was decided upon by the designers, Industrial Development Consultants, Ltd., because, in addition to being cheaper and easier to erect than the conventional roof truss type of building, it provided the required 90ft span with a shallow roof slope. The "British MonoRail" underslung crane system installed consists of runways suspended from the roof of the factory by special brackets and having trolley-mounted travelling cranes suspended under these runways. To afford a crane both transverse and longitudinal movement the trolleys on aligned runways can be connected by a bridge rail, enabling a crane on the bridge to be positioned over any point in a wide area. The use of simple standardised components for the crane system will enable it to be easily and rapidly altered to suit any changes in the flow of production, or extended with the factory building without interfering with existing production. Although these cranes give a lift of 11ft, the factory has a height of only 16ft to eaves, whereas a top-running crane for the same height of lift would need an eaves height of about 22ft. At present these handling systems can be designed with crane capacities of up to 3 tons, and cranes of up to 10 tons are under development.

The new factory, built by Industrial Development and Construction, Ltd., of Stratford-on-Avon, covers about 100,000 square feet, on a site of some 800,000 square feet. It consists of a single-storey building containing a heat treatment shop, a storage area, and a double-bay wire drawing shop, and with ancillary buildings for maintenance and services. The factory is constructed with standard bay spans of 90ft, the wire drawing area having a double span and the remainder being of single-span construction.

One bay of the wire-drawing shop has a single 2-ton motorised bridge crane, running the 195ft length of the shop on four parallel runways, enabling it to service the entire area of the bay. Trolleys running on each of the four runways carry double bridge girders, between which run a crane hoist on an electrically-driven trolley. The bridge is traversed along the shop through a motor-driven shaft fitted with four rubber tyres which contact the underside of each of the four runways. A push-button pendant attached to the hoist, controls lifting, lowering and the travelling motions along and across the shop. The power supply to the crane motors is provided through shoes which contact conductor rails fixed to one of the bridge rails and one of the runways. These conductor rails are out of normal reach, and as an additional safety measure are fitted with "Kant-Shock" sleeve insulation equipment which prevents maintenance workers from coming into accidental contact with the rails. One side of the second bay of this double-span shop has two runways set about 10ft apart and between which run three independent 1-ton bridge cranes. These smaller cranes have power-operated hoists and are fitted with long handles so that they can be pushed along by hand from the shop floor.

The 2-ton bridge crane in the wire-drawing shop connects with a similar crane in the storage bay which can be seen in our illustration. This crane is also suspended from four runways which extend the 150ft length of the shop, and its bridge rails traverse the full 90ft span. The heat treatment shop at the far end of the storage bay has three 1-ton hand-propelled cranes, two running between one pair of runways and the third on a separate pair of runways. This heat treatment shop has been so designed that additional cranes can be erected in any position as more production lines are brought into operation.

[Reply Card No. E1031]

Two-ton motorised double-bridge crane in the storage bay handling a cable drum during construction of the new factory

Magnetic Drums for Data Storage

MAGNETIC data storage drums designed for use in digital computers and automatic telephone exchanges are now being produced in two factories of the Sperry Gyroscope Company, Ltd., Great West Road, Brentford, Middlesex. Two types, "A" and "B" (a larger one), have been developed in collaboration with Automatic Telephone and Electric Company, Ltd. They were originally intended for automatic telephone equipment but are equally suitable for computer applications. The production processes begin at Sperry's Brentford factory and final assembly and testing are carried out at Feltham. Drums of these two types are being delivered to Post Office telephone exchanges in Great Britain for use in subscriber trunk dialling installations.

Larger drums, known as type "C," have been designed to suit computer manufacturers, including, in particular, Standard Telephones and Cables, Ltd. To provide, economically, a flexible range of storage assemblies, the type "C" drums are designed to consist of combinations of two standard sub-assemblies comprising a motorised drum unit and, in the case of larger capacity assemblies, multiples of slave drum units. All the units are coupled together to form a rotating cylindrical assembly with a common vertical axis, which is then shock-mounted in appropriate frameworks.

Both the motorised and slave units consist of a basic recording drum and head mounting mantle; the motorised unit also has a drive motor and eddy current braking disc. All units are of sealed construction to exclude foreign matter from the magnetic heads. Each drum is surrounded by a mantle drilled to a standard pattern of head-mounting positions, affording a variety of single, double and multiple head tracks. The complete drum assembly is provided with a common solenoid operated pump unit, supplying metered quantities of lubricating oil from a reservoir to each of the drum bearings. The solenoid is operated at frequent intervals by an outside electrical supply. In the unlikely event of the oil supply failing, the alarm system incorporated in the pump unit closes a pair of normally open contacts to operate any suitable warning device.

Main Particulars of Type "C" Magnetic Data Storage Drums

Type designation	1C	2C	3C	4C
Length of recording surface, inches	10	20	30	40
Diameter of recording surface, inches	12	12	12	12
Number of tracks (0·040 in pitch)	250	500	750	1000
Total capacity at 100 "bits"/inch	1×10^6	2×10^6	3×10^6	4×10^6
Number of magnetic head positions	434	868	1302	1736

Recording surface ... ... Nickel or oxide
Type of motor ... ... 3-phase, ½ h.p. squirrel cage, class-B insulation
Speed of drum ... ... 1500 r.p.m.
Duty ... ... Continuous
Operating temperature range 10–50 deg. Cent.

Part of the production line is illustrated. The photograph shows type "C" drum mantles, in which 434 holes are bored for mounting the recording heads. The specification calls for hole centres to be accurate to ±0·0005in vertically and within seventeen seconds of arc circumferentially. Later operations include keyway cutting and tapping to a specified depth.

[Reply Card No. E1032]

Boring mounting holes for recording heads in the mantles of type "C" storage drums

Fire-Protection of Structural Steel With Vermiculite

AN unfortunate paradox in the use of structural steel in buildings, which has often evoked comment both in this journal and in engineering circles generally, is that much of the economy and rapidity of this form of construction is lost

SHORTER REPORTS *(Continued)*

by the need—obligatory in the L.C.C. area and elsewhere—to encase the steelwork in concrete, to give it protection against fire. One example of a steel structure where it was possible to utilise a different method is described hereunder and shown in the accompanying illustration.

More than 40,000 square feet of vermiculite cladding, giving a four-hour fire protection, has been fitted to the steelwork of the new warehouse now being completed within the shell of the old Harringay Arena in North London. The warehouse is being built for Allied Food Distributors, Ltd. The cladding had to be completed within twelve weeks. "Vicuclad" panels were used. Where necessary, it was possible to fix the panels direct to the steelwork.

All slabs used in the building had a thickness of 2½in and a density of 26 lb per cubic foot, giving a four-hour fire rating in accordance with B.S. 476 : 1953. In the case of beams of standard size, the normal method of rectangular encasement was used. First, blocks known as "nogging pieces" were wedged and stuck between the flanges as primary fixtures for the side panels, and were centred according to the size of slabs being used on a particular beam. Side panels were then stuck to the nogging pieces and to the 2½in oversailing edge of the panels already fixed to the underside of the bottom flange.

Because of the great depth of the 4ft 9in inner perimeter beams, it was not considered practicable to adopt rectangular encasement. Instead, "Vicuclad" panels were prefabricated by the manufacturer, Commercial Vermiculite, Ltd., and fitted to follow the contours of the beams. For composite beams, the connecting fishplates were covered by using additional noggings. Panels were then fixed to these nogging pieces, ensuring that rivet and bolt heads were also covered by a minimum thickness of 2½in of "Vicuclad."

Where detailed shapes had to be cut in the cladding to accommodate electric light fittings, junction boxes and similar equipment, the panels were worked *in situ*. The vermiculite used in the manufacture of the panels is bonded with an inorganic binder to produce an incombustible slab, the slabs being fixed to steel surfaces with a fire-resistant adhesive developed by the manufacturers. Fire resistance tests of the system used in the warehouse have been carried out by D.S.I.R. and the Fire Offices' Committee Joint Research Organisation, and described in their report, FRO SI No. 882.

The architects for the reconstruction scheme were Eric Firman and Partners ; the contractor was Trollope and Colls, Ltd., and fixing in the warehouse was carried out by Mann-Reddington, Ltd.

[Reply Card No. E1033]

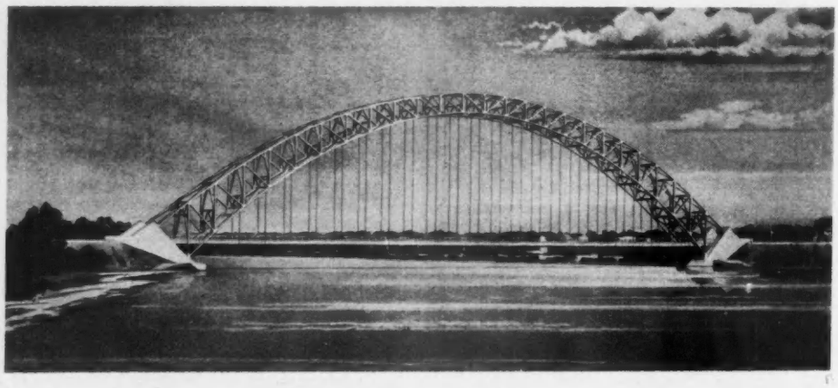
Vermiculite fireclading on structural steel in the former Harringay Arena

Indus River Bridge at Sukkur, Pakistan

A CONTRACT has been awarded and construction is starting on the new railroad bridge over the Rohri Channel of the Indus River, near Sukkur, in West Pakistan, which has been designed by D. B. Steinman, consulting engineer of New York. A joint-venture tender by Dorman Long (Bridge and Engineering), Ltd., and Gammon Pakistan, Ltd., was the lowest of five tenders received. Their tender of approximately 148,50,000 rupees, was accepted by the Railway Board, Ministry of Railways and Communications, last November.

The new bridge will be a steel trussed arch having a 806ft 9in span between the end pins of the bottom rib. The rise of the bottom rib is 180ft and the distance between the ribs at the crown is 24ft, making the total height of the structure 204ft. The bridge is designed to carry approximately E50 loading on one broad gauge (5ft 6in) track. In addition to the railroad track, the floor of the bridge will have a concrete deck, 15ft wide between kerbs, for use of class 80 (80-ton) vehicles in an emergency.

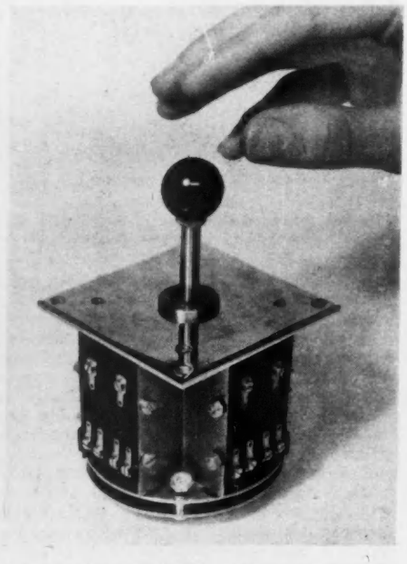
The new bridge is to be constructed 101ft downstream from and will replace the 70-year-old Lansdowne Bridge for railway traffic. The latter will be converted to highway use after the arch has been completed. The existing Lansdowne Bridge, completed in 1889 from plans by Sir A. M. Rendel, is a cantilever bridge with a main span of 820ft. It was originally designed as a combined highway and railway bridge but was later converted to a railway and pedestrian bridge. At the present time, the bridge is restricted to the lightest locomotives and a speed of only 5 m.p.h. The new bridge is scheduled for completion in the autumn of 1961.



Indus River Bridge at Sukkur, Pakistan

Joystick Control Switches

THE four-way joystick control switch illustrated is one of a new range developed by the Switch Division of Pye, Ltd., Cambridge. Many alternative arrangements are possible, but the switch illustrated is a four-way unit for selecting slow or fast motor speeds in each



Four-position joystick switch for use in a system requiring selection of two forward and two reverse speeds

direction by suitable connections to external resistances or motor windings. A four-way controller of this pattern can be used for selecting up to three speeds in each direction.

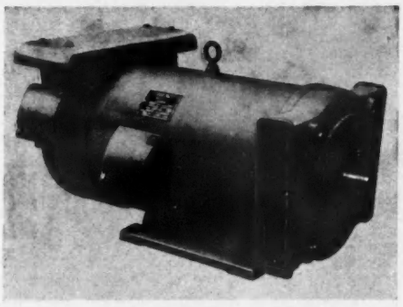
The flexibility of the system is increased by using a vertical movement of the joystick for certain functions. For example, depression of the knob when the stick is central may open an isolator switch to cut off the supply to the system, or the isolator may be opened automatically by the action of centring the stick. This return to the central " off " position may be spring-controlled or manual. Individual isolators can be incorporated in most control positions. These consist of micro-switches mounted beneath the bottom plate of the unit and operated by a projection from the bottom of the switch lever. In this way, the lever may be moved from one position to another without energising intermediate circuits, but on reaching the desired position may be locked in it, without operating the micro-switch, until released by an upward movement of the knob.

Control switches are mounted under a 3½in square chromium top plate. The control lever passes through an oil-filled spherical bearing and is guided by a gate plate mounted below the switches. Similar controllers may be supplied for operating potentiometers through their full range by means of a system of gears, giving infinitely variable control.

[Reply Card No. E1042]

Brushless Alternators

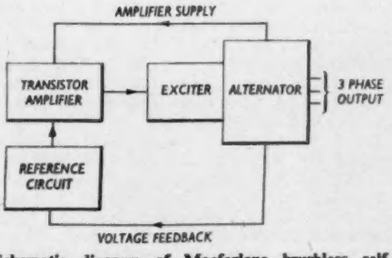
THE accompanying illustration shows a brushless self-excited alternator made by The Macfarlane Engineering Company, Ltd., Netherlee Road, Cathcart, Glasgow. It has a non-salient-pole revolving field with its revolving-armature exciter mounted on the same shaft. Both alternator and exciter are enclosed in the same



Macfarlane brushless self-regulating alternator with built-in revolving-armature exciter, rectifiers and control circuit mounted in a screen-protected ventilated frame. The control circuit gives voltage regulation to ±1½ per cent of set value

cylindrical shell. The exciter is an a.c. machine and its three-phase output is fed directly to rectifiers which rotate with the shaft and supply their d.c. output to the main alternator field. Field current for the exciter is derived from a " transistorised " preamplifier.

Control of the output voltage (see schematic diagram) is by matching a feed-back proportional to the terminal voltage of the alternator against an artificial reference derived from Zener diodes. Any divergence from the normal terminal voltage appears as an error signal which is amplified, first by the transistor amplifier, and then by the exciter, before being applied as a correcting m.m.f. to the alternator field. Voltage feed-back is derived either from stator tappings or from the output terminals, through a transformer. The Zener diodes in the reference circuit operate at just above the breakdown reverse voltage : in this condition the voltage across the diodes remains constant, irrespective of current and constitutes a suitable reference against which the output voltage can be compared. The supply to the transistor amplifier is taken from an auxiliary winding in one or two slots of the alternator stator. This arrangement helps to reduce voltage surges on the transistors resulting from alternator transients.



Schematic diagram of Macfarlane brushless self-regulating alternator

The static control equipment, including the transistor amplifier, is mounted inside the end-shield near the air inlet (left of illustration) and is finned to provide cooling with minimum temperature drift. The effect of temperature variations in the reference circuit is eliminated because the reference diodes are selected in matched pairs.

The field rectifier unit is part of the rotating system, being mounted on an extension of the shaft at the non-driving end, where it is protected by the end-shield and, like the static control gear, is cooled by the incoming air. The rectifier consists of hermetically sealed silicon diodes mounted on fins specially designed to improve cooling.

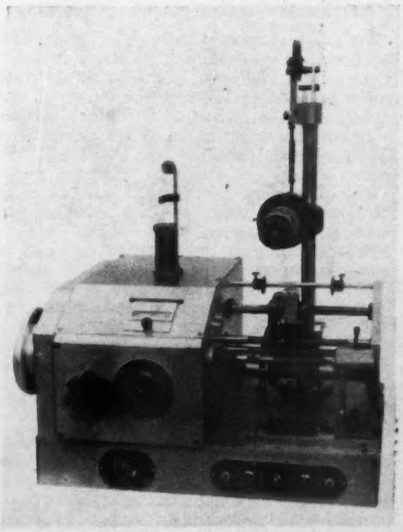
All the control gear is self-contained within the alternator shell, with the exception of an external hand-operated rheostat which is used to vary the voltage setting.

A range of four frame sizes covers ratings from 10kVA to 150kVA, three-phase, three-wire and four-wire. The voltage ranges at 50 c/s (1000 and 1500 r.p.m.) or 60 c/s (1200 and 1800 r.p.m.) are as follows : 190/205V, 205/220V, 220/235V, 235/250V, 380/410V and 410/440V. All windings have class-E insulation (impregnated with thermo-setting varnish) in accordance with B.S. 2613 : 1957.

[Reply Card No. E1051]

Bench-Mounted Winding Machine

A BENCH-MOUNTED winding machine, illustrated below, is manufactured by Westool, Ltd., St. Helen's, Auckland, Co. Durham. This machine is fitted with a five-figure reset revolution counter, and is suitable for winding at speeds up to 4000 r.p.m. The rate of acceleration from zero to maximum speed is determined by the setting of a plastic handwheel which operates a potentiometer controlling a Warner electric clutch coupled to the driving motor. Coils can be wound up to 5in in diameter and 3in in length in gauges from 30–50 S.W.G. on the machine. Its reel carrier spindle accommodates reels up to 6in in diameter, but for the winding of fine gauges from 47–50 S.W.G., a small " over end feed " is also supplied.



Winding machine for coils up to 5in diameter and 3in long in wire from 30 to 50 S.W.G.

The traversing mechanism incorporates two Warner electric brakes coupled to two worm wheels in constant mesh with two lead screws. Traverse length is set by the adjustment of stops which actuate micro-switches energising and de-energising the brakes to impart positive and instantaneous reversal of direction. Wire spacing (turns per inch) is set by a handwheel with reference to a calibrated scale engraved in S.W.G. sizes or in decimals of an inch.

[Reply Card No. E1052]

Bar Mill Modernisation

THE semi-continuous bar mill at the Steel, Peech and Tozer branch of the United Steel Companies, Ltd., is being modernised. The bar mill was laid down nearly forty years ago and the existing drive is through line shafting and gearing from a single 3000 h.p. variable speed a.c. motor. In order to introduce greater flexibility into the mill's operation, this drive is being replaced by a number of separate variable speed d.c. motors, totalling 3400 h.p., and some of the rolling mill stands are being renewed. The first stand on the present mill is a pinch roll stand which is to be replaced by an 18in horizontal roll stand. The first two stands of the roughing section of the mill are also to be replaced by 18in horizontal and vertical stands, respectively. The horizontal stands will be powered by a single 350 h.p. d.c. motor and the vertical stand will be equipped with a 250 h.p. d.c. motor.

A series of paired drives is to be installed on the remaining mill stands. Thus, stands Nos. 3 and 4 will be driven by a 600 h.p. d.c. motor, Nos. 5 and 6 by a 700 h.p. d.c. motor, Nos. 7 and 9 by a 750 h.p. d.c. motor, and Nos. 8 and 10 by a 750 h.p. d.c. motor. A new motor room is to be built to house all these drives, which will be supplied from 2200kW of grid-controlled rectifiers. The modernisation includes also the installation of a flying shear after No. 6 roughing stand, the provision of a modern oil lubrication system throughout the mill and the installation of a high-pressure water system for billet descaling. The latter will make it possible to improve the surface condition of the rolled bars, particularly in the case of material destined for bright drawing. The main contractor for the scheme is Brightside Foundry and Engineering Company, Ltd., the electrical equipment, including the motors and rectifiers, being supplied by Associated Electrical Industries, Ltd.

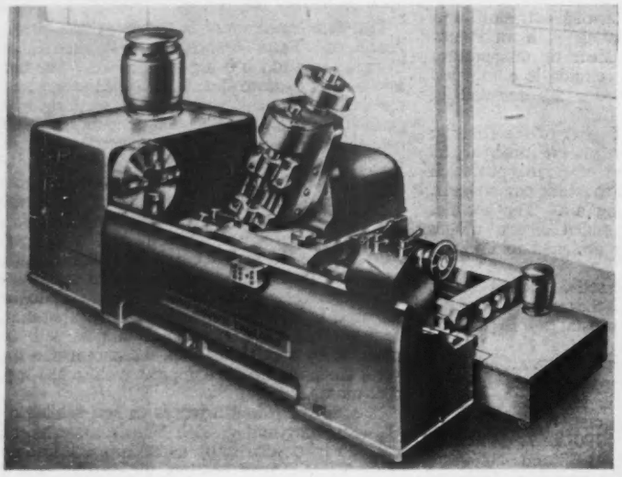
Standardisation of Farm Machinery

ALTHOUGH in recent years there has been rapid development in the design and production of all kinds of agricultural machinery, progress in the standardisation of components has lagged. In the case of some farm machinery, standards have been laid down, but designers are often charged with being too slow in bringing the standards into use. On the other hand, there are some farm machines to which no degree of standardisation is applicable. The whole subject is an important one for the agricultural engineering industry. In order to provide an opportunity for a full discussion on standardisation, the West Midlands branch of the Institution of Agricultural Engineers is holding a meeting at Gosta Green Technical College, Birmingham, on Monday, February 1, at 7.30 p.m. A panel of four experts will put forward their views and will then answer questions. The panel will include Mr. R. Berry of the British Standards Institution (agricultural engineering division) ; Mr. Rowland Ward, a farmer ; Mr. Claude Culpin, chief machinery adviser of the National Agricultural Advisory Service, and Mr. J. M. Chambers (Massey-Ferguson, Ltd.), who is a member of the governing body of the National Institute of Agricultural Engineering and of the B.S.I. engineering division's council. Tickets of admission to the meeting may be obtained (free of charge) by applying to Mr. R. M. Chambers, 69, Northumberland Road, Leamington Spa.

SHORTER REPORTS *(Continued)*

Pinion Hobbing Machine

A HOBBING machine for producing double helical pinions up to 12in diameter, 30in face width and 80in overall shaft length, which is now made by the David Brown Machine Tool Division, Manchester, has an accuracy guaranteed to be well within the tolerances permitted in B.S.S. 1498/1954, Grade "A." To ensure that the machine has a long working life to high standards of accuracy, it is equipped with liberally proportioned slideways, large diameter feed screws and hob spindle bearings, hardened and profile ground gears; all the high-speed shafts are mounted on ball or roller bearings. It incorporates permanently mounted measuring equipment, and accurately ground dividing plates are provided for mounting on adaptors on the dividing worm and lead screw. Measuring equipment is also provided for the hob arbor for checking uniformity of motion between hob and work spindle.



Pinion hobbing machine for the production of double helical pinions up to 12in diameter and an overall face width up to 30in

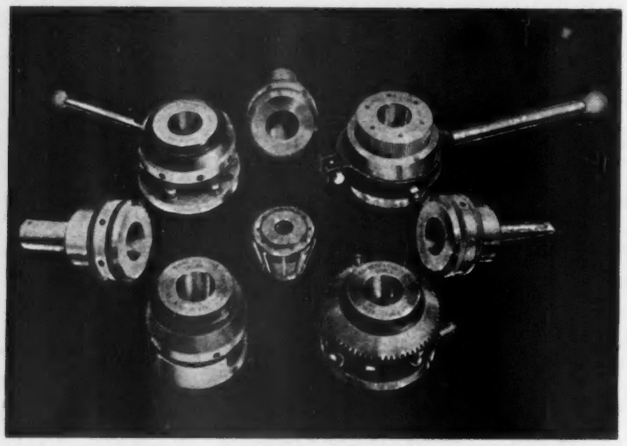
The 20in diameter dividing worm wheel of the machine has 150 teeth of a low-pressure angle to ensure that an adequate number of teeth are in simultaneous contact with the dividing worm. A 4in diameter precision lead screw is located axially by ground and lapped flat thrust washers at one end, and the nut assembly which is mounted on the hob slide comprises two widely spaced nuts. One of these nuts can be rotated through a worm and worm wheel to eliminate backlash. The hob saddle has a motor-driven rapid traverse for use when setting up the machine, and limit switches are provided to prevent over-run.

[Reply Card No. E1061]

Machine Tool Collet Equipment

A REPRESENTATIVE group of the "Multisize" collet equipments now being made by F. Burnerd and Co., Ltd., 5, Balfour Place, London, W.1, is shown in the illustration here. In this design of collet the body is formed with a number of radial, equally-spaced, slots in which narrow blades are slidably fitted. These blades have a taper formed on their outer edge, and as the body is moved in the taper bore of a housing the blades are pushed out to grip, or drawn in to release, a workpiece. The blades are spring loaded to their release position in the body and their parallel movement in the body ensures that a workpiece is gripped along the full blade length. Each size of collet has a gripping range of $\frac{1}{8}$in and each collet is guaranteed to hold a ground test bar to within 0·0005in close to the face and 0·001in at a distance of 4in from its face. Only six sizes of holders are required to cover the full range of collet sets covering diameters from $\frac{1}{16}$in to $2\frac{1}{4}$in, whilst special designs are available for handling hexagon and square bar stock.

The range of work holding devices made to this design include a lever-operated dead-length chuck which, through its lever, can be opened and closed without need for stopping a machine. A key-operated chuck is available in two models, one for mounting on a machine with an inserted adaptor and the other for mounting using a flanged adaptor. A collet chuck is made by the firm for direct mounting to every recognised national and international standard spindle design. A key-operated chuck for direct mounting on machine tables for stationary or slow-revolving operations incorporates automatic key ejection mechanism to prevent accidents. For holding parallel shank drills, reamers, taps, &c., in lathes a range of collet toolholders has now been developed. To facilitate mounting of these toolholders they are made with both parallel and taper shanks.



Representative group of "Multisize" collet equipment

[Reply Card No. E1062]

Artificial Recharge of Aquifers

WITH last summer's shortage of water and the current reorganisation of the water industry both topical subjects, considerable interest centres on the results of experiments carried out recently by the Metropolitan Water Board, in recharging well stations in the Lee Valley. This work was discussed last Tuesday at the Institution of Civil Engineers when the paper "Some Experiments in Artificial Recharge in the Lower Lee Valley" by E. S. Boniface was presented for discussion.

Four experiments were carried out over a four-year period. Potable water was passed into the chalk or tertiary sands of the area during the winter, when demand is low and supply is ample, at three well stations, and it was found possible to abstract an augmented yield from the same wells the next summer and autumn. The following paragraphs are reproduced from the conclusion of Mr. Boniface's paper.

"The experiments have shown that a considerable quantity of river-water, surplus to the Board's winter requirements, can be stored in the Thanet Sand and the Upper Chalk of the Lower Lee Valley for use during periods of peak demand in the following summer and autumn months at economic cost to the Board, the quantity recovered being 38 per cent of the water used in artificial recharge; the percentage recovered increasing as the experiments progressed. Furthermore, three important well stations were rehabilitated.

"Of the 2700 million gallons of water used, about 1600 million gallons remained in the aquifers to benefit the other wells in the area, the previous steady fall in water levels having been checked. In addition, wells outside the area of detectable influence profited to an unknown extent. Altogether, the outputs of a number of private wells have been maintained instead of falling. Hence, indirectly, further calls on the Board's supply have been prevented.

"Using spare filter capacity, producing 8 m.g.d. in a period of low demand, the safe additional well output, averaged over the summer and autumn months, rose to $1\frac{1}{2}$ m.g.d.; furthermore, during the months of maximum demand, the supply was augmented by about 3 m.g.d. The only real disadvantage disclosed was the temporary increase in the hardness fraction of some of the well-waters influenced by recharge. In no case, however, did the increase affect the purity and wholesomeness of the water.

"To adumbrate the future of this method of recharge is not easy when the chief criterion has to be the direct benefit to the statutory water authority alone. The obvious necessity of only using water of first-class quality for recharge, in an area where so many wells have been sunk, immediately restricts the maximum amount of water available for it. Further, the water should only be taken during periods of surplus river flows. With a spare filtration capacity of the order of 50 m.g.d. during part, at least, of the winter period, it would appear theoretically possible to increase the safe additional yield of the Board's well resources by about 9 m.g.d. on a *pro rata* basis if suitable recharge sites are available. In practice it would be very doubtful if the necessary combination of favourable circumstances, including availability of surplus river-water, filtration and pumping plant, and mains, would allow recharge to take place at a rate approaching 50 m.g.d., bearing in mind the need for overhauls, repairs, &c., in "off peak" periods. A forecast, based on a gradual extension of operations in areas adjacent to the existing recharge-abstraction sites up to the practical limit set by the main reticulation and plant availability, places the safe additional well yield in the immediate future at a total of about 3 m.g.d. There is a possibility of a further increase if a new filtration works of larger capacity replaces Lee Bridge."

The full paper is published in the December issue of the Institution's *Journal.*

Underwater Echo-Ranging

AN account of work in progress at Birmingham University on developing underwater echo-ranging for the fishing industry was given in a paper read to the Radio and Navigational Aids Group of the British Institution of Radio Engineers by Professor D. G. Tucker on January 7. Six current research projects were described, the first of which was an electronic scanning system which would "look" in several directions at once (according to the number of transducer sections employed) during the transmitted pulse. Work is being devoted to improving definition and increasing the speed of scan with the aim of seeing individual fish and details of trawls. Another investigation in hand concerns wideband echo-ranging, by which the frequency-response of targets may be studied by pulse height analysis and the possibility of identifying fish is brought into view. One of the problems here is to develop a wideband directional receiver, and experiments are being made with an array having a 9 to 1 frequency ratio and a reasonably constant beam width of 5 deg. A bottom-lock echo-sounder using frequency modulation is under development for showing the height of fish above the sea bottom, enabling those in the lowest two fathoms to be seen, some of which normally may be obscured by the irregular bottom trace. A further line of study is a continuous wave echo system based on the fact that echoes returned from moving objects undergo a Doppler frequency shift and thus can be separated from the transmission. The impermanence of cathode ray tube displays is recognised as a limitation, and a method using a vidicon camera tube is being developed for transferring a c.r.t. picture, integrated in blocks of ten pulses, to a chemical recording plant. Among other work mentioned in the paper was an electronic system for stabilising the beam in the water to counter the effect of rolling, using fixed transducers and varying the beam frequency in accordance with a gyro reference signal.

Galway Sluice Barrage

THE Galway sluice barrage, which was completed last year, forms part of the Corrib-Clare drainage scheme undertaken by the Commissioners of Public Works in Ireland to improve the drainage of agricultural lands bordering Lough Corrib and its tributaries. The waters from Lough Corrib were controlled by a stone weir with limited sluice capacity, which provided water power for milling and depth for navigation. To cope with the increased flood discharge resulting from the new drainage works and to maintain an adequate summer level in Lough Corrib the stone weir has been replaced by a sluice barrage across the River Corrib just north of Galway City.

The new barrage consists of fourteen hinged-leaf or bascule gates, each about 20ft long by about 5ft effective height arranged in an arc of a circle and adjoining the original pair of sluices which have been retained. Each gate can be raised or lowered by a pair of hydraulic rams built into the supporting piers and controlled by a valve on each pier. A salmon pass, a smolt pass and two elver passes are incorporated in the barrage, which is illustrated below.

The type of gate installed is hinged about a torsion tube along its lower edge, from which it cantilevers. The jacks are pinned to cranks at each end of the torsion tube. The advantage sought was a clean appearance, free from overhead lifting gear. (See Mr. H. D. Morgan's paper "Control of Flow by Gates and Valves," *Proceedings I.C.E.*, July, 1957.) The hydraulic rams are supplied with oil at a pressure of about 1100 lb per square inch from an electrically-driven pump in a small power house on the river's right bank. This house also contains reserve oil accumulators, safety devices to guard against excessive pressure, and a petrol-driven stand-by pump. Each gate is operated independently and since the gates are normally fully closed during the summer period, each one is provided with a mechanical lock.

The whole of the works were designed by Sir William Halcrow and Partners. The gates were made in Ireland by J. and C. McGloughlin, Ltd., and the hydraulic equipment was supplied and installed by Automotive Products, Ltd., of England. The civil engineering works were carried out by direct labour by the Commissioners of Public Works under the direction of their chief engineer, Mr. J. P. Candy, M.I.C.E.

Voltage-Controlled Overcurrent Relay

AN overcurrent relay designed to protect alternators against both overload and short circuits has been added to the range of the meter, relay and instrument division of The English Electric Company, Ltd., Marconi House, Strand, London, W.C.2. When used for main or back-up protection of alternators, overcurrent relays have often to provide adequate fault settings on loads close to full load as well as giving normal overload protection. These requirements conflict because the sustained short circuit current on external faults may be limited to a value below full load. For full protection against overload and short circuit conditions, therefore, measurement of current alone is insufficient, and the new CDV22 relay (illustrated in Fig. 1) also measures the terminal voltage. The relay, therefore, has two current/time characteristics, and changes automatically from one to the other on a given fall in voltage. This is achieved by the inclusion in the same case of an instantaneous under-voltage relay, having one pair of contacts connected across a resistor in the shading coil circuit of the inverse time-overcurrent relay element. In normal voltage conditions the voltage relay contacts are open and the torque developed by the inverse time-overcurrent element with the resistor in circuit is such that the relay operates for normal overload protection. To take advantage of the thermal capacity of most alternators, the operating time under overload conditions is longer than the corresponding time provided on a standard inverse time-overcurrent relay.

If the voltage falls to a predetermined value in fault conditions, the under-voltage relay is released and its contacts close, short-circuiting the resistance in series with the shading coil of the overcurrent relay. This increases the torque developed by the overcurrent element two and a half times so that the relay operates on its fault characteristic. Fig. 2 compares operating times for given currents on the overload characteristic (curve 1) and the fault characteristic (curve 2).

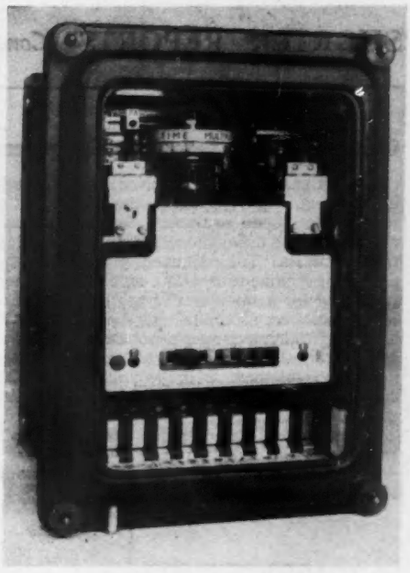


Fig. 1—Overcurrent relay with alternative characteristics selected by voltage conditions

Two forms of the relay are available. Type A changes its characteristic when the volts fall to approximately 60 per cent of normal or below and is for use when the generator is solidly earthed. In Type B the change occurs at approximately 30 per cent of normal volts, and this form of the relay is for use where the generator is earthed through a resistance.

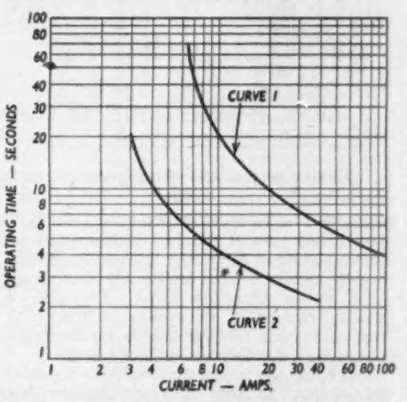


Fig. 2—Characteristics of 5A relay in overload conditions (curve 1) and fault conditions (curve 2)

An auxiliary unit controls the operation indicator, which may be reset by a push-button on the cover of the relay case. The trip and alarm contacts are rated to carry 7500VA for 0·5 second, with maxima of 30A, 660V, a.c. or d.c. Relays are supplied in single-pole or triple-pole form in draw-out cases, which can be mounted either horizontally or vertically.

[Reply Card No. E1073]

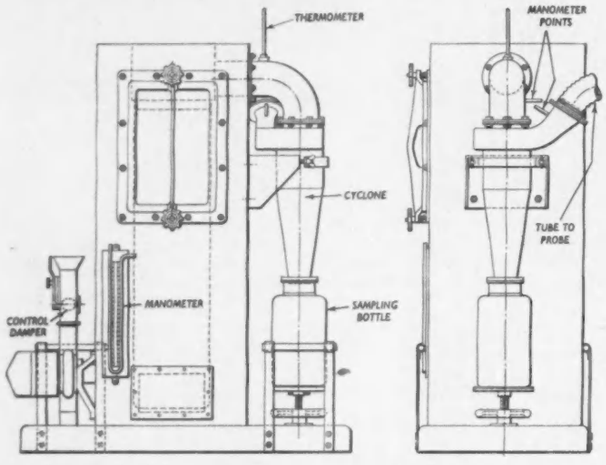
Galway sluice barrage

SHORTER REPORTS *(Continued)*

Grit and Dust Sampling Equipment

PARTICULARS have been received from Mancuna Engineering, Ltd., Denton, Manchester, of a recently developed equipment for the measurement of grit and dust in boiler flue gases and industrial processes. The equipment uses a standard miniature cyclone tube with a textile sleeve filter, providing for a minimum sampling gas volume of 84 cubic feet a minute with the possibility of operating the device over a normal period of at least thirty minutes. An advantage claimed with the equipment is the volume of gas that can be handled with it and the considerable sample by weight of grit and dust which can be collected over an extended period, thereby minimising the sampling error.

As shown in the accompanying drawing, the equipment incorporates a single "D584" Mancuna-Dustex cyclone tube of cast aluminium alloy to the side of which is clamped a welded aluminium main filter bag casing and bedplate. A glass bottle is held up to the cyclone dust outlet by an adjustable table. The clean gas outlet at the top of the cyclone is fitted with a bend connected into the side of the filter casing containing a suitable textile filter sleeve.



General arrangement of equipment for flue dust and grit sampling

The baseplate is extended to carry a portable exhaust fan the inlet of which has a bayonet fitting for quick coupling to a flange on the side of the main casing. The fan outlet is fitted with a short exhaust duct having a locking butterfly damper which is used for controlling the gas volume drawn through the unit. Provision is made below the access door for the fitting of a water manometer which is connected by rubber tubing to pressure tapping points on the inlet and outlet of the cyclone. This manometer, together with a thermometer, provides for a determination of gas volume drawn through the unit. In addition to the main assembly, sampling nozzles, a metal probe and a length of flexible metal hose for attachment of the probe to the cyclone inlet, are provided.

As the cyclone tube fitted is similar to those in the firm's "D584" grit arresters, the equipment can be used to forecast the performance of the full-scale grit arrester. From a determination of the collection efficiency of the cyclone tube the grit and dust content in the flue gases can be measured at any time merely by the weighing of the amount of grit collected in the bottle under the cyclone tube over a given period and by relating this weight of collected material to a simple formula or graph. In addition an adequate truly representative sample of collected material is available for examination and analysis.

The sampling point for the equipment is selected in a straight run of flue or stack about ten diameters downstream of the nearest bend. For an initial determination of tube efficiency a pitot tube reading is taken at the centre and the total volume and average gas velocity calculated. When the average velocity in feet per minute has been determined the nearest size of sampling nozzle is selected from a graph provided which shows nozzle diameter against sampling volume.

The nearest size of nozzle as indicated on the graph is fitted to the probe and through the flexible metallic tube probe is connected to the cyclone inlet. From another graph there can be determined the required pressure drop across the cyclone appropriate to the operating temperature and the sampling volume. With the probe set centrally in the duct and facing upstream the fan is started and its outlet damper adjusted to obtain the required pressure drop across the cyclone. The equipment is then run for ten minutes to condition the filter bag to the gas condition; it is then stopped and cleaned of grit and dust before a sampling run is carried out over a period of up to thirty minutes or until the bottle is between one-third and one-half full of grit and dust. During this test run the pressure drop is maintained constant by adjustment of the fan damper.

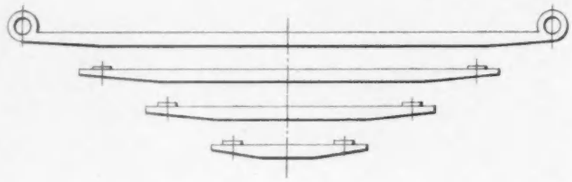
Using the sample collected in this test run there are then calculated the collection efficiency of the cyclone tube and the inlet grain loading to the unit in grains per cubic foot from the sampled gases. When this efficiency test has been carried out and the collection efficiency for the cyclone tube determined, subsequent tests, where general operating conditions are similar to those during the test, can be run without use of the filter bag, using the cyclone tube only. The grain loading in the effluent gases is calculated by using the relationship between the already proven efficiency of the cyclone tube and the weight of grit collected in the bottle.

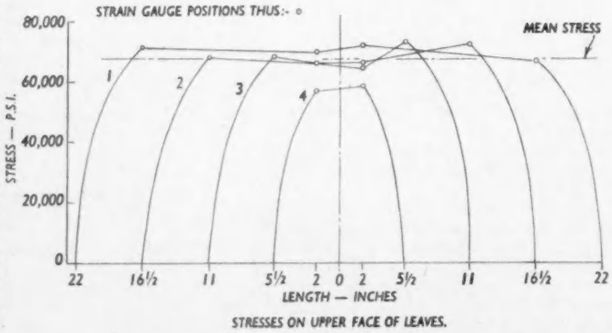
[Reply Card No. E1081]

Profiled Leaves for Laminated Springs

ACCORDING to Toledo Woodhead Springs, Ltd., there persist in use for the design of leaf springs formulæ which are mere modifications of the simple theory for a uniformly stressed spring in a material of infinite shear modulus. The departures from exactitude of these equations render optimisation, in which is implicit differentiation, highly unreliable, and hence many springs are in production in which the maximum stresses vary significantly along the length of the spring and even from leaf to leaf. Since the energy absorption depends on the second power of stress, a flexural spring of rectangular section has at least three times the weight of a uniformly stressed spring, and since a flexural spring on a vehicle suspension is liable to contribute seriously to the unsprung mass, these departures from optimum emphasise the inferiority of the laminated spring to bulk springs or even torsion springs. Toledo Woodhead has, therefore, initiated a study of the behaviour of the leaf spring by Messrs. Plint and Partners, Ltd., which has resulted in a method of spring design sufficiently accurate to allow optimum springs to be designed.

This theory, however, showed that the conventional methods of forming leaves could yield only unsatisfactory results, and therefore the sponsors undertook the development of processes for producing at competitive costs leaves with the profile controlled in plan as well as in elevation. In general, such a spring will appear as suggested in the sketch, and a stress distribution along the centre of the top faces of the leaves as shown in the graph; the stresses fall off towards the ends of the leaves, although of course less seriously than with leaves of uniform thickness, because the leaf does not taper to an edge and because it is loaded well inside the end; the load is transferred from leaf to leaf by "buttons" impressed in the leaves. In any case, it is clear that, since the moment of inertia of the section is not linear with the depth of the section, a linear profile cannot result in a uniform maximum stress. Nevertheless, the ability to roll leaves of varying thickness has been demonstrated to allow better results to be obtained with fewer leaves; the spring illustrated weighed 16 lb 4 oz and performed the same duty as a six-leaf spring weighing 23 lb 5 oz in which the two bottom leaves were devoid of load localising buttons and suffered stresses up to 83,000 lb per square inch. In addition, the facility of varying the thickness allows the depth of the main leaf to be determined independently of the strength of the eyes.





Stresses in "rational" spring: because of the finite length of the seating, the design stress cannot be realised in the shortest leaf

Profiled leaves can be produced in the same materials and for work at the same stresses as conventional leaves. The springs will accept axial load, torsion, and even transverse load if the design demands it, e.g. Hotchkiss drive. The internal damping of the "rational" leaf spring is, as on conventional springs, high and variable.

[Reply Card No. E1082]

INDUSTRIAL NEWS

Merger of Aircraft Firms

An amalgamation of the aircraft and guided weapon interests of Vickers, Ltd., The English Electric Company, Ltd., and The Bristol Aeroplane Company, Ltd., has been announced this week. For this purpose a new company is being formed, with three wholly-owned subsidiaries, namely, Vickers-Armstrongs (Aircraft), Ltd., English Electric Aviation, Ltd., and Bristol Aircraft, Ltd. The shares of the joint company are to be held by the principal companies in the following proportions : Vickers, 40 per cent, English Electric, 40 per cent, and Bristol, 20 per cent. No new issue of capital is involved. The Bristol Aircraft Company's helicopter interests are not included in the merger. The financial responsibility for types of aircraft and missiles already in production will remain with the appropriate principal company.

The board of the new joint company will control policy ; it will include directors from the three principal companies and from the three subsidiaries. The day-to-day operational responsibility will be undertaken by these three subsidiaries which will retain their own names and identities. This structure, it is stated, will secure the benefits of integration whilst preserving the reputation and goodwill of the three firms. The staff and workpeople will continue to be employed by the subsidiary companies apart from a small central staff employed by the new company. The boards say they are satisfied that the new grouping will ensure sound prospects of stable employment in the future. The Minister of Aviation has been fully consulted about this merger. It is understood that he welcomes it and that he looks upon the new company as constituting one of the major aviation groups which would qualify for Government support. The three companies involved have also stated that negotiations are taking place with the Hunting group, with a view to its aircraft design and manufacturing company, Hunting Aircraft, Ltd., participating in the new company.

Shortening the Working Week

In the current issue of its *Bulletin*, the British Employers' Confederation comments on the fact that trade unions pressing claims for a shorter working week have, in many cases, said that they are seeking a genuine reduction in hours worked and not merely an increase in the number of hours paid at overtime rates. Some trade unions have also said, the *Bulletin* adds, that their claims can be met without loss of production. There may be industries, the Confederation remarks, in which present output per man-hour can fairly readily be raised, and in which the enhanced hourly wage rates consequent on a reduction of normal weekly hours can be offset in this way.

But, the British Employers' Confederation asserts, in those industries where it is the machine rather than the man which determines the speed of working, hourly output can only be increased in the immediate future by a reduction in wasted time. Employers in such industries, the Confederation urges, are entitled to expect full support from the unions in this matter, otherwise labour costs will almost inevitably rise if hours are reduced. There remain, however, the *Bulletin* continues, several industries, particularly those providing services to the public, where there can be little prospect of offsetting the cost of any increase in hourly wage rates if present levels of service are to be maintained.

Unofficial Strikes

In his chairman's statement to the shareholders in Martins Bank, Ltd., Sir A. Harold Bibby, Bt., comments that last year's official statistics show that productivity has increased slightly more than wages. That, he says, has enabled the cost of living to remain stable and, with it, the real value of the wage packet. But it must not be forgotten, Sir Harold adds, that much of this increase in productivity has only been made possible and brought about by the investment of large sums of money in modernising old and installing new equipment.

Sir Harold goes on to emphasise in his statement that " the biggest fly in the ointment is the spate of unofficial strikes " which, he points out, are condemned equally by trade union leaders and employers. Now that the Trades Union Congress has taken this matter seriously in hand, he says, there ought to be no doubt that a solution will be found, particularly as so many of these unofficial stoppages occur from demarcation disputes between the different unions. Unless, the statement continues, the trade unions can guarantee that agreements, which they have freely negotiated, are enforceable on their rank and file there is little or no justification in reaching such agreements, nor if they fail in this essential is there justification for the unions themselves, either from their members' or the employers' point of view.

Railway Wages

When the last railway wage award was agreed in June, 1958, the British Transport Commission set up an independent committee to make a detailed review of the railway wage and salary structure. The report of that investigation is expected to be ready in April. In the meantime, the National Union of Railwaymen, without the co-operation of the two other railway unions, has been pressing a wage claim which has twice been rejected by the British Transport Commission. This rejection has led to threats of an unofficial one-day strike on February 1 by members of the N.U.R. in the London area ; such a strike is, however, in no way supported by the N.U.R. executive.

Last Monday, the British Transport Commission made a statement about the forthcoming report on the railway wage structure. It said that the Commission naturally would not declare its attitude to the report until it was received and the committee's terms of reference provided that " neither the Commission nor the unions could enter into any prior commitments." It was also possible, the statement added, that it might take some time to deal with the implications of the report, especially if substantial alterations to wages and salaries were involved. But, the statement continued, the Commission would be prepared, immediately on receipt of the report and subject to its nature, to discuss with the unions what " interim action could justifiably be taken." Moreover, the Commission would be prepared to make any such " interim action " take effect as from January 11. The Commission's statement ended with the observation that the staff concerned could feel that a little further patience would not place them at a disadvantage.

Ionising Radiations

The Ministry of Labour has published the Second Preliminary Draft of the Factories (Ionising Radiations) Special Regulations. It contains revisions to the draft code, issued in July, 1957, for the protection of workers engaged in operations involving the production, emission or use of sealed sources of ionising radiations. The original draft included a general invitation to industry, associations and any others concerned to comment on the proposed regulations. The Ministry says that a large number of suggestions were received.

In the new draft, the schedule specifying the maximum permissible radiation doses has been remodelled, taking into account the views of the Medical Research Council and the revised recommendations of the International Commission on Radiological Protection. The schedule has been simplified by restricting it to certain ionising radiations which are ordinarily met with in industrial work with sealed sources. It is considered that this revised schedule contains the essential requirements as to permissible limits relating to sealed sources used in industry at present, although this question is one which is to be kept under review. The regulations propose a number of revised definitions. One brings within the scope of the regulations certain machines which are not intended to produce ionising radiations but which in fact do so ; another makes it clear that a sealed source consists of the radioactive substance and the bonding or container which seals it. There are new provisions dealing with tests for personal exposure and medical supervision, with the examination of people employed in the processes and the procedure to be adopted where workers employed in the processes move from one factory to another. Fuel elements used or intended to be used in a nuclear reactor will not be covered by these regulations which also exclude from their application ionising radiations used for medical purposes in factories or rooms specially set apart. Further regulations covering the use in factories of open " sources " of ionising radiations are being drafted.

The " second preliminary draft " may be obtained at H.M. Stationery Office, price 1s. 3d. Comments on it must be submitted to the Ministry of Labour by April 15 and when these have been considered, the statutory procedure for making the regulations will be carried out.

PERSONAL AND BUSINESS

Appointments

MR. EDWIN E. HEWETT has been appointed sales engineer by Nash and Thompson, Ltd.

MR. W. A. NICOL and MR. W. W. FEA have been appointed directors of John Lysaght, Ltd.

MR. HARTFORD M. KING, sales director of Geo. W. King, Ltd., has been appointed assistant managing director.

MR. WILLIAM HENRY LONGLEY has been appointed director and chief accountant of Simms Motor Units, Ltd.

PEARSON PANKE, Ltd., announces that Mr. Leslie Power has joined its staff as representative for the Midland area.

MR. A. W. EVANS has been appointed manager of Ambuco, Ltd., a subsidiary of Buell Engineering of New York.

MR. T. H. CLARKE, formerly sales manager of Patterson Lamps (1953), Ltd., has been appointed general manager.

MR. A. E. GREGG, A.I.E.E., has been appointed a director and general manager of Crompton Parkinson (Chelmsford), Ltd.

AIR COMMODORE JAMES WARBURTON and MR. JACK VIVIAN THOMAS have been elected to the board of Maxim Silencers, Ltd.

MR. J. C. GREIG, has been appointed sales director of the Jacobs Manufacturing Company, Ltd., and Frank Guylee and Son, Ltd.

LONDON MIDLAND REGION, BRITISH RAILWAYS, has announced the appointment of Mr. R. C. S. Low as works manager at Harwich.

EASTERN REGION, BRITISH RAILWAYS, announces the appointment of Mr. J. Stacey as supplies officer in the department of the supplies and contracts manager.

MR. F. W. H. SHAW has been appointed managing director of Submarine Cables, Ltd. He succeeds Mr. F. S. H. Lemon who has retired after more than forty years' service.

THE CONSOLIDATED PNEUMATIC TOOL COMPANY, Ltd., announces the appointment of Mr. H. H. E. Georgel as contracting division manager in succession to Mr. H. H. Hicks.

MONSANTO CHEMICALS, Ltd., announces that Mr. W. H. Ritchie has been appointed development manager—projects, and Mr. N. G. H. Thomas, development manager—products.

LACY-HULBERT AND CO., Ltd., announces that Mr. V. S. Robinson has been appointed chief consulting engineer, and Mr. G. W. Jarvis has assumed control of the drawing office as chief draughtsman.

MR. JOHN S. BAILLIE, deputy chairman of Harland and Wolff, Ltd., has been appointed to the board of A. and J. Inglis, Ltd., and of D. and W. Henderson, Ltd., in place of Mr. J. R. Lee who has resigned on account of ill health.

BLAW KNOX, Ltd., has announced the appointment of Rear-Admiral A. J. Tyndale-Biscoe, M.I.Mech.E., F.R.Ae.S., Messrs. C. R. Banks, J. Conacher, M.I.Mech.E., J. C. Grist and H. Houghton as divisional directors.

THE MINISTRY OF AVIATION announces that Mr. D. A. HUTTON-WILLIAMS has been appointed director of the Inspectorate of Armaments, and Colonel H. S. Wood, deputy director. Colonel Wood has been granted the temporary rank of Brigadier.

NORRIS WARMING HOLDINGS, Ltd., has announced that Mr. A. Davey, M.I.H.V.E., has been appointed joint managing director of Norris Warming Company, Ltd., and Mr. N. Aldcroft has been appointed joint managing director of F. A. Norris and Co., Ltd.

THE METALLURGICAL EQUIPMENT EXPORT COMPANY, Ltd., announces that Mr. D. F. Campbell, formerly chairman, has been appointed president. The chairmanship is to be held in rotation by the managing directors of the companies constituting the consortium. Mr. R. B. Potter has been appointed for the next two years, with Mr. P. Wrightson as deputy chairman for the same period.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, Ltd., announces that Sir Alexander Sim has resigned from his position of chairman of the company and director of the subsidiary and certain associated companies. Dr. J. N. Aldington, a director of the company has been appointed chairman. Dr. P. Dunsheath, M.I.C.E., M.I.E.E., has retired from the board of directors after forty years' service with the company.

DAVEY, PAXMAN AND CO., Ltd., announces that Mr. Harold Riggall has resigned from the chairmanship and from the board of directors on his retirement from the managing directorship of the parent company, Ruston and Hornsby, Ltd. Sir Percy Sanders, deputy chairman, has resigned for health reasons, but remains a member of the board. Mr. W. J. Ruston has been elected chairman, and Mr. V. R. Prehn has been elected deputy chairman.

VICKERS-ARMSTRONGS, Ltd., announces the following appointments : Vickers-Armstrongs (Engineers), Ltd., Mr. A. E. Reddell, M.I.Prod.E., has been appointed a director and to the office of director-in-charge, Weymouth works, and Mr. F. A. E. Pritchard, M.I.Prod.E., has been appointed a special director and to the office of general manager, Weymouth works. Vickers-Armstrongs (Aircraft), Ltd., Mr. J. Ferguson Smith has been appointed a special director.

BELL'S ASBESTOS AND ENGINEERING (HOLDINGS), Ltd., Bestobell Works, Slough, Bucks, announces that in order to provide for succession, all members of the Holdings Company board over the age of sixty are relinquishing their board appointments in all the operating companies. Mr. A. J. M. Miller becomes the new chairman of Bell's Asbestos and Engineering, Ltd. (operating company), and Mr. D. Allen and Mr. F. R. Bedwell have been appointed joint managing directors.

FOUNDRY SERVICES INTERNATIONAL, Ltd., announces that Mr. E. Weiss, managing director, has been appointed chairman. Mr. A. O. Grundberg has been appointed deputy managing director and has resigned his position as managing director of Sandvik Swedish Steels, Ltd. Mr. P. D. Norman has been appointed a director of Foundry Services, Ltd. Mr. B. Rosen has been appointed managing director of Sandvik Swedish Steels, Ltd., in succession to Mr. Grundberg.

THE ENGLISH ELECTRIC COMPANY, Ltd., announces that Mr. C. T. M. Bagnall has been appointed to a new post of manager, publicity and information services. The new title carries responsibility for both the company's public relations and publicity departments. The reorganisation follows the retirement of Mr. J. I. Hall, public relations officer. Mr. M. B. Schroeder has been appointed joint deputy publicity manager (technical), and Mr. C. G. Hollowell has been appointed to the parent company as joint deputy publicity manager (general).

FOSTER-WHEELER, Ltd., announces the following changes to its board of directors : Mr. C. E. H. Verity has been appointed managing director in succession to Mr. G. H. Hopewell. Mr. Verity continues as manager, steam division. Mr. Hopewell remains a director and has taken the position of deputy chairman. Mr. R. B. Kerr has been appointed deputy managing director and manager, process plants division. Mr. H. T. Collinswood has retired from the post of manager, process plants division, but remains a director of the company.

Business Announcements

DECCA RADAR, Ltd., is to establish a radar training school at Cowes Airport.

RHODEN PARTNERS, Ltd., has moved from Park Crescent, London, W.1, to 19, Fitzroy Square, London, W.1 (telephone, Euston 9696).

SIR THOMAS BENNETT has resigned from the chairmanship of Crawley New Town Development Corporation in view of the heavy pressure of his private work.

HATTERSLEY (ORMSKIRK), Ltd., has appointed Markland Scowcroft, Ltd., Bromley Cross, Near Bolton, as stockist of its gun metal and cast iron valves.

LEE GUINESS, Ltd., states that the company's sales engineering and contracts department has been transferred to 25, Victoria Street, London, S.W.1 (telephone, Abbey 6762).

THE YALE AND TOWNE MANUFACTURING COMPANY, BRITISH MATERIALS HANDLING DIVISION, has opened a new service depot for London and the home counties at Ripple Road South, Barking, Essex (telephone Dominion 5945).

KELVIN AND HUGHES (INDUSTRIAL), Ltd., Kelvin House, Wembley Park Drive, Wembley, Middlesex, states that an agreement has been concluded between Kelvin and Hughes, Ltd., and the Curtiss-Wright Corporation of America for the exclusive right to manufacture and sell the non-destructive testing equipment of the other partner.

DAVEY, PAXMAN AND CO., Ltd., Colchester, has granted a manufacturing licence for its diesel engines to Ets. Dujardin et Cie, of Lille, France, which will manufacture the Paxman 7in range of engines for oilfield, rail traction, marine and industrial purposes for sale in France and French overseas territories.

THE WAKEFIELD CASTROL GROUP has announced the formation of a group works division, responsible for the overall administration of its twelve production centres in the United Kingdom. Mr. C. R. Woodfield has been appointed general manager of the new division and Mr. H. G. Priest is manager of its production department, based at Castrol House, London.

PANTAK, Ltd., Vale Road, Windsor, Berks, has concluded an agreement with Usines Balteau of Liège for the marketing in the United Kingdom of lightweight portable industrial X-ray equipment. The equipment will complement its existing mobile units and will consist of two oil insulated units of 140kV and 200kV capacity and three gas insulated units of 150kV, 180kV and 300kV capacity.

THE GENERAL ELECTRIC COMPANY, Ltd., Magnet House, Kingsway, London, W.C.2, has reorganised its general products group into five new groups, each under the control of a group managing director, as follows : domestic equipment group, Mr. E. A. Fowler ; installation equipment group, Mr. R. H. Phillips ; lighting and heating group, Mr. D. L. Tabraham ; Osram group, Mr. A. E. Page ; radio group, Mr. M. M. Macqueen.

LONDON TRANSPORT announces that the garages and depots grouped in the four central area engineering divisions under the control of Mr. K. G. Shave, A.M.I.Mech.E., have been re-grouped in three divisions, known as divisions A, B and C. Divisional engineers are as follows : Division A, Warner Road, Camberwell, S.E.5, Mr. A. E. Butler, A.M.I.E.E.; Division B, Manor House. Seven Sisters Road, N.4, Mr. R. G. Hills ; Division C, Dollis Hill, Edgware Road, N.W.2, Mr. H. W. Cromack.

RICHARD THOMAS AND BALDWINS, Ltd., announces that all sales of electrical sheet and strip manufactured at its Midland section are now handled by Richard Thomas and Baldwins (Sales), Ltd. The Midland section sales department for electrical sheet and strip has been transferred to Richard Thomas and Baldwins (Sales), Ltd., but will continue to operate from Wilden, Stourport-on-Severn. Mr. P. M. J. Boulasse has been appointed manager of the department and Mr. G. F. Astle and Mr. R. G. Martindale, M.I.E.E., have been appointed joint sales managers.

THE CEMENTATION GROUP OF COMPANIES is to build and equip a £3,500,000 luxury hotel near Teheran for the Pahlavi Foundation. It will be known as the Royal Hilton Hotel. The Cementation Group is responsible for the design and has retained as architects Messrs. Foroughi, Zafar, Sadegh and Ghiai, of Teheran ; and as consulting architects, Messrs. Raglan Squire and Partners, of London. Residential accommodation will be provided in a tower block, rising some 220ft, and the hotel will be one of the world's tallest buildings to be constructed in an earthquake zone.

THE NUCLEAR POWER PLANT COMPANY, Ltd., and the A.E.I.-JOHN THOMPSON NUCLEAR ENERGY COMPANY, Ltd., have agreed to become partners on an equal basis in all respects under the name of The Nuclear Power Group. The head office of the Group is at Radbroke Hall, Knutsford, Cheshire. Constituent members of the Group are : Associated Electrical Industries, Ltd., Clarke, Chapman and Co., Ltd., Alex. Findlay and Co., Ltd., Head, Wrightson and Co., Ltd., Sir Robert McAlpine and Sons, Ltd., C. A. Parsons and Co., Ltd., Strachan and Henshaw, Ltd., John Thompson, Ltd., Whessoe, Ltd.

STANDARD TELEPHONES AND CABLES, Ltd., states that, following the recent announcement of the merger of the power cable businesses carried on by Enfield Cables, Ltd., and by Standard Telephones and Cables, Ltd., respectively, a new company has been formed, Enfield-Standard Power Cables, Ltd., Connaught House, 63, Aldwych, London, W.C.2, and main works at Brimsdown. Mr. F. C. Wright, managing director of Standard Telephones and Cables, Ltd., and the Hon. John Grimston, managing director of Enfield Cables, Ltd., and Enfield Rolling Mills, Ltd., will alternate as chairman of Enfield-Standard Power Cables, Ltd. Principal officers of the company are Mr. E. C. Lee, general manager ; Mr. G. H. Bairstow, general works manager, and Mr. M. J. Smith, commercial and technical manager.

CONTINENTAL AFFAIRS

by Our Continental Editor

Continuous Galvanising Plant at August Thyssen-Hütte

DURING the last few months a continuous strip galvanising plant has come into operation at the steel plant of August Thyssen-Hütte A.G., Duisburg-Hamborn. The plant operates according to the Armco-Sendzimir system and produces between 6000 and 8000 tonnes per month in the form of coils or sheet. It is stated to be the first of its kind in Germany, the galvanising process until now having been confined to sheet material.

The first strip hot-galvanising plant was built by T. Sendzimir in 1931 for Armco Steel Corporation, Middletown (U.S.A.). To-day there exist some thirty galvanising lines of this design.

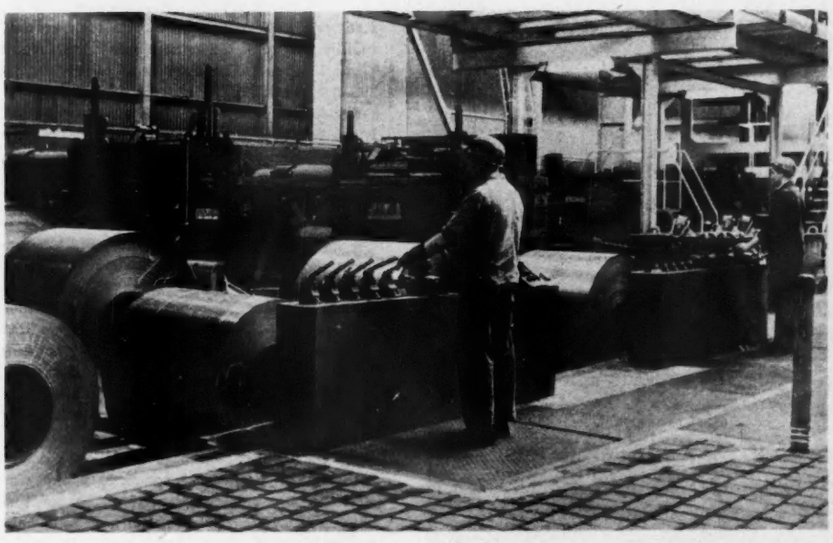


Fig. 1—Uncoiling machines at the head of the galvanising line where coiled strip is loaded by crane

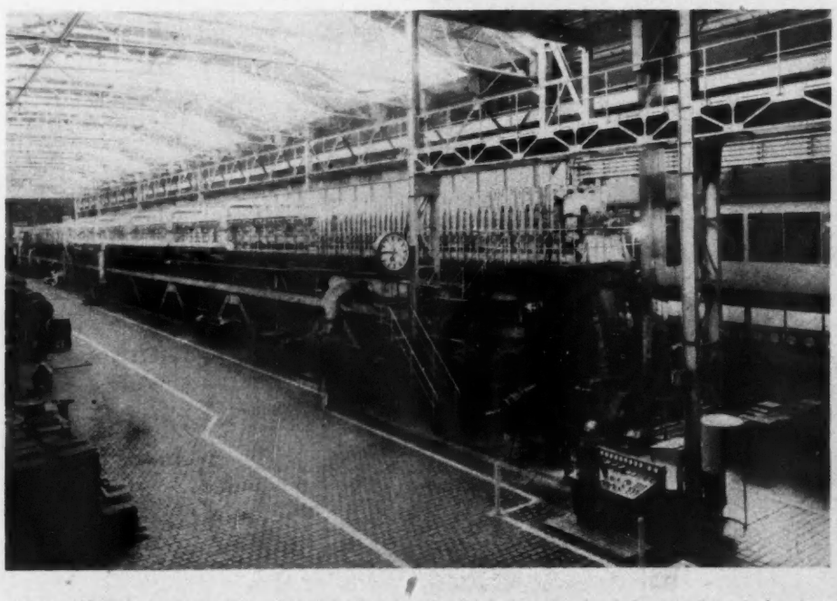


Fig. 2—After passing through the 125m-long furnace, the strip enters the zinc bath through a sloping duct, and after passing round a roller at the bottom of the bath, emerges vertically and enters the overhead cooling system. The control desk for the whole installation is seen in the right foreground

In the A.T.H. Works, the galvanising process is carried out in a department adjoining the cold-rolling mill which supplies the starting material. At the head of the 255m-long line which extends into the finishing hall of the mill, cold-rolled coils weighing between 10 and 16 tonnes are brought in by fork-lift trucks to be weighed, after which they are placed into an intermediate store. Subsequently they are carried by crane to the two uncoilers (Fig. 1). From there, the strip passes through a shears and spot welding machine, the latter serving the purpose of joining up successive coils into a continuous length. In order to make it possible for the strip to stop during welding while continuing to move further down the line, a double-loop carriage is fitted which can support a 180m-long loop.

The strip then reaches a 125m-long furnace in which there is maintained in the first section an oxidising atmosphere which burns away any oil clinging to the strip. The light oxidation which occurs at the same time is afterwards removed in the reducing section where the strip is annealed and raised to a temperature slightly above that of the zinc bath of 450 deg. Cent. Through a closed duct in which a protective atmosphere is maintained, the strip passes downwards into the zinc pot and under a roller at the bottom, and up again over an overhead cooling zone. Our second illustration shows this part of the plant. After cooling, the strip passes through a series of adjusting rollers and another take-up loop and feed rollers. It is then possible either to wind the strip again into coils or to cut it up into sheets up to 4·25m long, and stack it for weighing and despatch. Satisfactory packing is regarded as being of the greatest importance. Coils for export to the U.S.A., for instance, are wrapped in oiled paper, given an outer wrapping of galvanised sheet and mounted on pallets.

Information Exchanges

When problems of a technical nature occur in an industrial organisation, it may well be that the solution is already available elsewhere. Much valuable time and effort could therefore be saved by an adequate exchange of information. This was the basic idea which led the German Productivity Council (R.K.W.) to set up all over the country information exchange groups in which managers, engineers, business men, and others can interchange their experiences; in Nordrhein-Westphalia alone there exist at present about seventy such groups. While the value of this co-operation cannot always be expressed directly in hard cash, cases have been reported where clear cut savings have been initiated as a result of group discussions.

Electronic Components Exhibition

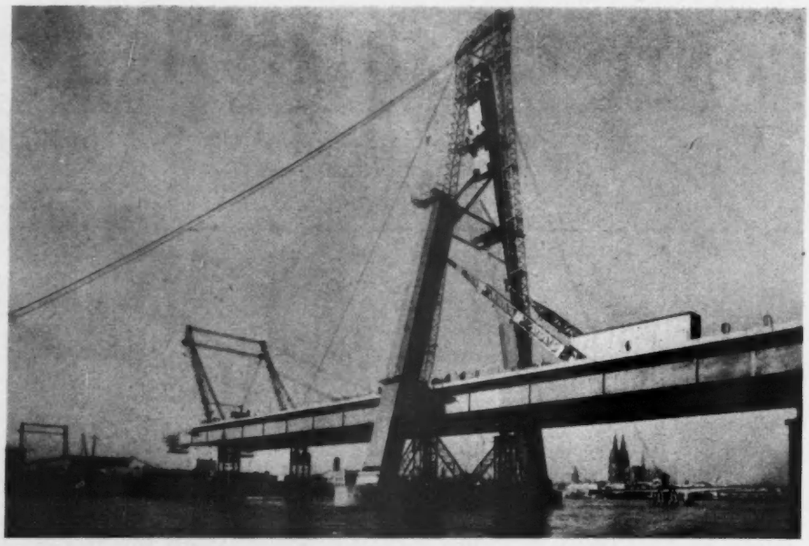
The Third International Exhibition of Electronic Components will take place at the Porte de Versailles exhibition grounds, Paris, during the period February 19 to 23. This year's exhibition will occupy a total hall space of 14,000 square metres, an increase of 20 per cent over last year. The number of stands will be about 400 and approximately one-quarter of the exhibitors will be from abroad. The exhibition is being organised under the patronage of the Fédération Nationale des Industries Electroniques (F.N.I.E.) by the Syndicat des Industries de Pièces Détachées et Accessoires Radioélectriques et Electroniques (S.I.P.A.R.E.). Inquiries should be made to S.D.S.A., 23, rue de Lubeck, Paris (16e).

German Roads

The vast programme of road construction in Western Germany is expected to cost about £500 million this year. It will be many years before the target figure of 800 miles of motorways is reached in Great Britain, whereas in West Germany there are already 1400 miles of motorways, and plans to double this length. The West German programme of new construction will be at about five or six times the rate of the British programme, the difference in effort being particularly marked in urban areas.

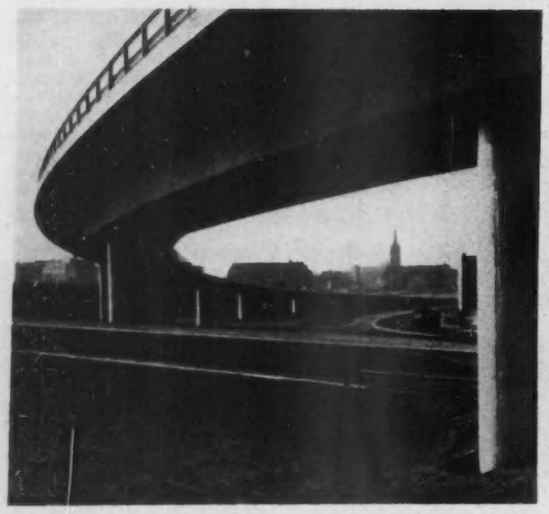
In Cologne, the Severin bridge over the Rhine (RIGHT) connects the city with the suburb of Deutz about ¾km upstream of the Cologne–Deutz Bridge, and will also carry a share of autobahn traffic in the direction of Frankfurt. Unusual in appearance because of its asymmetrical design, the Severin Bridge comprises two box girders on either side of an orthotropic deck. It was finished last Autumn.

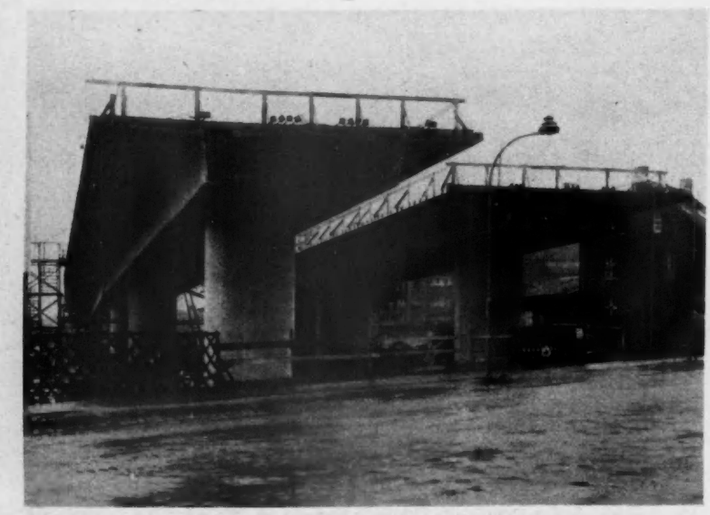
The steelwork is 691m long and 31m wide, including the cantilevered footpaths, and is continuous over six spans of which the two major ones, of 302m and 151m, are on either side of the only river pier. This carries the single tower from which the long spans are part-supported by inclined steel cables. The design achieves the very low specific weight of 412 kg steel per square metre of deck. (See "The Engineer," September 18, 1959.) Erection of the tower is illustrated.



Another unusual bridge, this time in concrete, is the one over the river Mangfall near Weyarn on the Munich–Salzburg autobahn. Here, a narrow temporary structure had replaced a war-destroyed plate girder bridge of 90m+108m+90m spans. The new bridge, begun in 1958, has two lattice girders in prestressed concrete, with cross-beams at the level of the top flanges and a prestressed concrete deck. The prestressing reinforcement consists of 26mm diameter round bars of "St 80/105" steel with rolled anchorage threads. The bridge is being built in cantilever construction by Dyckerhoff and Widmann K.G., Munich, and is believed to be the first of its kind. We referred to this bridge on page 32 of our January 1 issue.

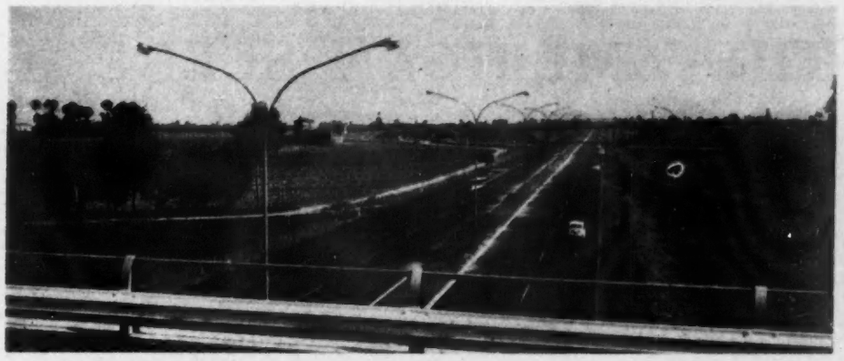
At the foot of the page we show elevated roadways of prestressed concrete, under construction and completed, serving the town of Dusseldorf. These viaducts form interchanges and an elevated approach road serving the North bridge across the Rhine, completed in 1958. There is a large roundabout on the north approach; the route is free from all crossings at grade, and includes multi-level intersections.

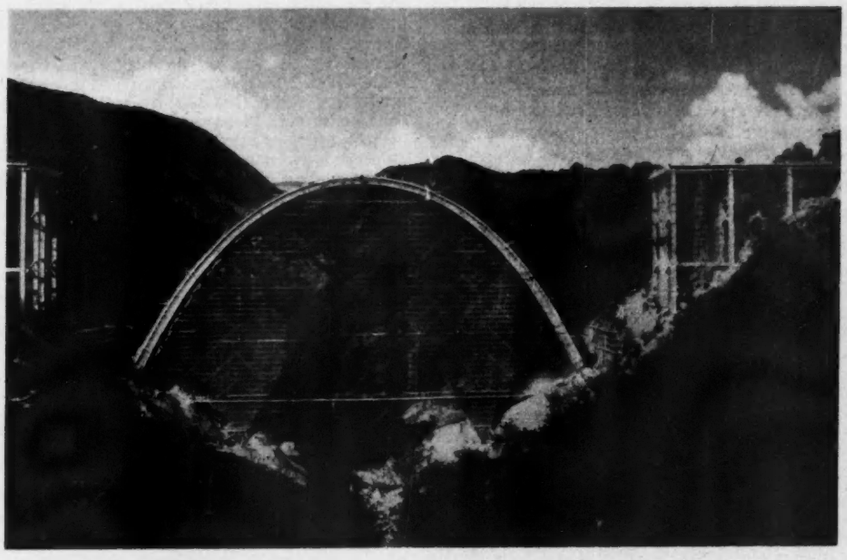




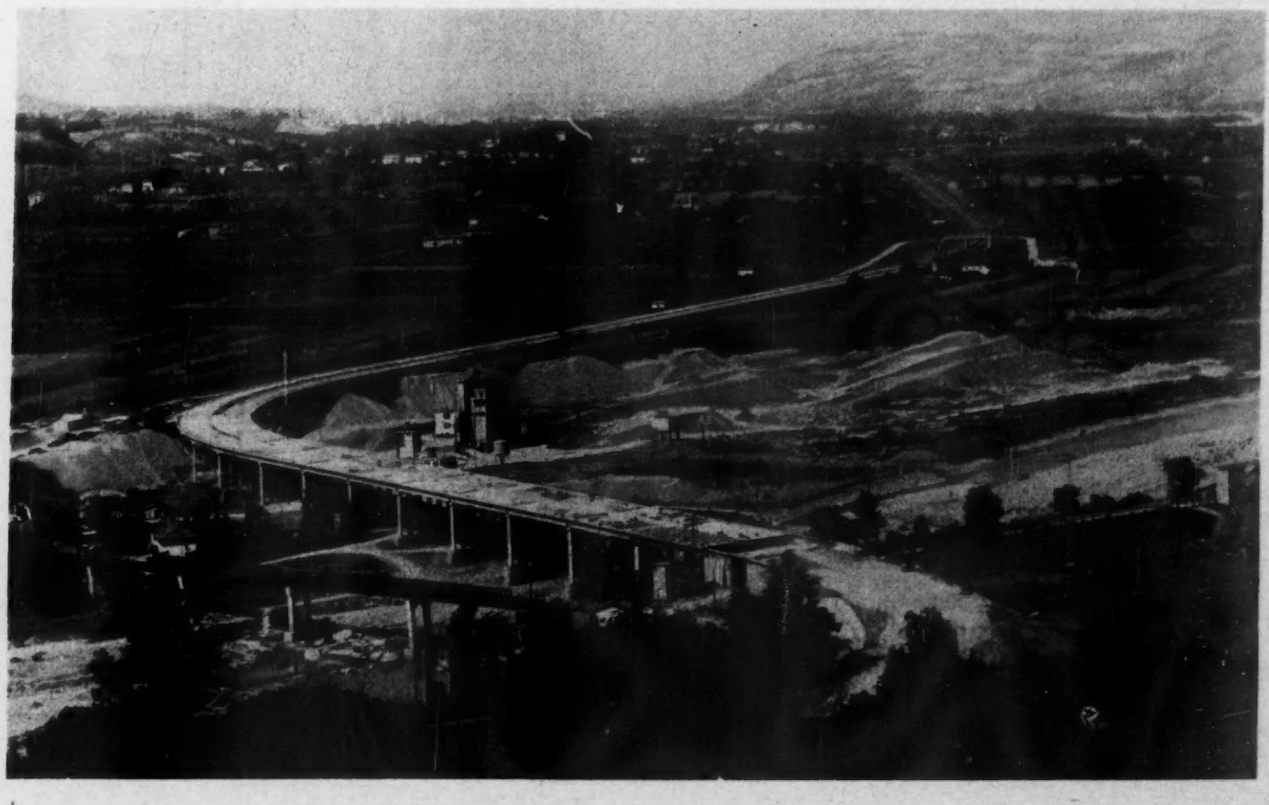
Autostrada del Sole

Of the 738km-long Milan-Naples "Autostrada del Sole," begun in 1956, nearly one-third was commissioned between December, 1958, and last July, all substantially ahead of schedule. Sections now in use of Italy's first major toll road comprise the 195km from Milan to Bologna, including a sixteen-span prestressed concrete bridge 1176m long over the River Po, and the 40km from Capua to Naples ; a view near Piacenza is shown on the RIGHT. The width is 24m throughout, made up of two double-lane carriageways and 3m hard





shoulders, with a 3m centre strip ; provision has been made for a third lane. The road is 15cm black top on 20cm of stabilised graded macadam. Already well advanced is the next stage, Bologna-Florence. Crossing the Reno (BELOW), the road enters the Apennines, where difficult terrain requires many bridges and tunnels, including twelve large arch bridges such as the Biscione Bridge near Pian del Voglio with a 130m main span, the third largest, which is shown under construction in the CENTRE. The arch falsework is in position in this view. The approach spans, and also the viaduct in the foreground of the lower view, give a good idea of the slenderness of the structures along the route and the upper view equally well shows crash barriers, lighting columns and lane markings which are typical.



THE AMERICAN SCENE

by Our American Editor

Industrial Processing Applications of Electron-Beam Radiation

No. II—(*Continued from page 78, January 8*)

Penetrating high voltage electron-beam radiation has, within the past few years, drawn widespread industrial attention as a promising processing tool, and many American companies and institutions are now engaged in intensive programmes of research and application. The efforts of these groups extend from fundamental studies on the basic interaction of radiation with matter to the actual operation of radiation processing facilities. While many types of radiation sources have been proposed and investigated over the past few years, the Van de Graaff and microwave linear particle accelerators are now generally recognised as the principal sources of radiation for industrial use.

Industrial Processing Techniques

MANY mechanical methods have already been used experimentally in the irradiation of unusual product geometries or thicknesses. Among them are the roll treatment of film ; the spinning of fluids in tubes ; the bombardment of wire insulation from each side continuously ; the rotation of wire on its axis while moving continuously under the beam ; the rotation of spherical objects while under the beam ; and the treatment of solids at inclined angles. In addition there is a large potential area of application which can be realised by a modification of the beam itself. Greater scan widths than the present standard of 15in are under development. There are also many possible ways that other magnetic systems can be used, external to the basic accelerator, to change its characteristic geometry.

The first technique is the magnetic inversion of a beam to give simultaneous double bombardment from one accelerator. Rigid materials are commonly irradiated with an electron beam from only one side. Under these conditions, the optimum product thickness to use with a monoenergetic electron beam is about two-thirds of the total range of the beam. At this thickness, the efficiency, which is a combination of total energy absorption and dose uniformity, is at a maximum. In general, double bombardment increases the efficiency because a greater percentage of the beam range can be used, from each side, with the same overall uniformity of dose distribution as that obtained in the optimum case of single bombardment. The optimum thickness for double bombardment is about 2·4 times that of single-side treatment. This means, for example, that a 2 MeV electron beam used in a double bombardment process on an industrial product has a useful penetrating ability nearly equal to that of a 5 MeV beam applied to a single side of the same product.

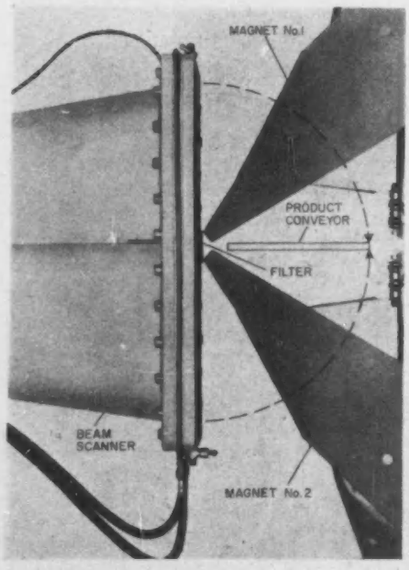


Fig. 8—Model of beam inverter employing two magnetic fields to bend each half of a scanned beam through 90 deg.

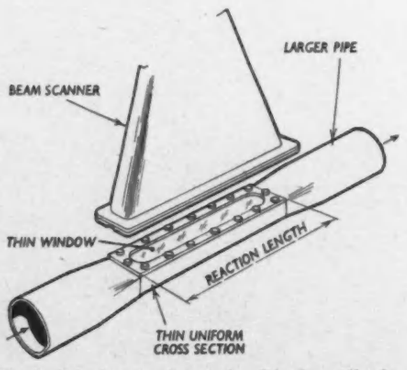
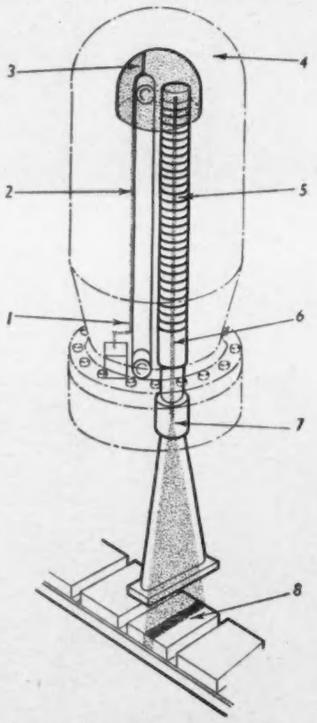


Fig. 9—Reaction chamber employed in the application of electron beams to fluids in continuous flow

Solid materials which are processed on a conveyor in boxes or trays can be turned over manually or automatically, to accomplish the double irradiation. However, this cannot be done when packaged fluids, such as liquid solutions of drugs, are treated, because the fluid will move between exposures. Also, other solid materials which are not treated on conveyors may sometimes be difficult to turn over between passes. For example, some electrical cables are too stiff to be wound around small pulleys to return past the beam for a second bombardment with the opposite side exposed. In all these cases, simultaneous bombardment from both sides is needed to gain the higher efficiency and increased penetrating ability of double bombardment. This can now be done with the beam from a single accelerator. The High Voltage Engineering Corporation has developed a method in which two separate magnetic fields are used to bend each half of a scanned beam through an arc of 90 deg. The two portions of the beam converge from opposite sides in a plane at right angles to the original plane of the scanned beam, as shown in the accompanying illustration. This process can be used on products up to about 6in wide with 15in scanning. When tests are completed on a linear scanning system for 30in width, the useful width in the inversion process can be increased to about 12in. Tests made with a 2 MeV beam from a Van de Graaff accelerator show that the integrated dose a product receives in passing by the exit of the magnet-deflecting system is uniform within 10 per cent over the entire scanned width. These tests also show that the amount of beam power lost by scatter in air to the magnet pole pieces is less than 10 per cent of the available power entering the magnetic system. Thus, beam inversion can be made practical for industrial applications with existing accelerators.

Another technique uses special filters to increase the efficiency of double bombardment. As mentioned previously, the efficient use of



1.—Electric charge is sprayed on a rapidly moving insulating belt.
2.—The belt mechanically carries the charge to an insulated, hemispherical, high-voltage terminal.
3.—At the terminal, the charge is automatically transferred from the belt to the terminal, thereby establishing a high potential or voltage difference with respect to the lower end of the accelerator.
4.—The high-voltage terminal is insulated from the shell of the accelerator by an atmosphere of compressed nitrogen, which prevents arc-over.
5.—A glass and metal tube, maintained at a very high vacuum, provides the only path for the electrons to escape from the cathode.
6.—The electrons forming the high-energy beam are accelerated to extremely high velocities by the potential difference between the terminal and the lower end of the accelerator.
7.—This electron beam is scanned by magnetic coils to cover uniformly the product passing beneath.
8.—The dosage received by the irradiated product depends on the speed of the conveyor belt, the energy of the beam, and the width of scan.

Fig. 10—Operating principle of the Van de Graaff electron accelerator

electron-beam power depends on the fraction of the total energy which is intercepted and the acceptable uniformity of dose distribution. Since the characteristic absorption curve for mono-energetic electrons passes through a maximum, uniformity of dose can be improved by inserting another absorber, such as a filter, between the beam and the product. If the filter is of a certain thickness, the efficiency for double bombardment can be increased to more than 70 per cent despite the added loss in the filter, because the uniformity of dose is so greatly improved. Of course, the thickness of product at the maximum efficiency is not as large when a filter is used.

An intermittent filter achieves further gains in efficiency through increased uniformity. The energy absorbed in the product is the sum of the effects which would be achieved separately if the filter were permanently in, or permanently out, corrected for the proportion of time during which each condition exists. The net effect depends on both the filter thickness and the percentage of the total time during which it is in the beam. The latter factor is called the " per

Pulses of very high-frequency r-f power from a radar-type power generator are fed to an accelerating waveguide.
In the accelerating waveguide a travelling r-f wave of the proper phase velocity is propagated.
Electrons are injected into the waveguide in bunches at the proper intervals to be trapped in the field of the travelling wave. These electrons are accelerated by the wave to very high speeds.
Focusing coils collimate the electron beam.
The electron beam is scanned for uniform dose distribution.

Fig. 11—Operating principle of the microwave linear electron accelerator

cent interruption." The uniformity of dose and the fraction of energy intercepted have been calculated for a number of intermittent-filter systems to find the optimum combination of filter thickness and per cent interruption which would produce the highest net efficiency. The optimum filter for a mono-energetic 2 MeV beam is about 0·25 gramme per square centimetre used in a 33⅓ per cent interruption of the beam. The depth efficiency calculated for this system is 84 per cent in double bombardment.

Either a moving screen or a rotating fan can be used to interrupt the beam. In an experiment, a three-bladed fan rotating at 200 r.p.m. was used with a 2 MeV Van de Graaff accelerator. The results confirm that the use of the fan makes a significant change in the dose-depth curve. This technique is easily adaptable to an industrial application where double bombardment is used, with or without a beam inverter. Only simple, mechanical equipment is needed to produce an efficiency of about 80 per cent.

A third technique involves the application of electron beams to fluids in continuous flow under elevated pressure and temperature. The availability of new alloys in the form of thin sheets and thin-walled tubes with high ratios of strength-to-weight, together with the development of new beam-handling techniques, makes this possible. High efficiencies can be achieved if the design of the irradiation chamber takes advantage of

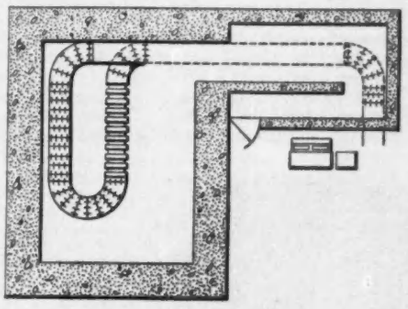


Fig. 12—Conveyor layout for continuous processing of materials by irradiation

electron beams which are scanned to a long length in one direction and yet are confined to a narrow width in the other direction. Several advantages are realised by aligning the reaction tube or narrow chamber with the direction of scan. A long path for mixing during the irradiation period is obtained. This ensures that the irradiation dose is uniformly distributed in the fluid without requiring too high a velocity or incurring too large a pressure drop, and probably without the need of special baffles to eliminate " dead " spots which occur over short lengths of flow. Furthermore, large accelerator beam currents can be used without over-heating the thin wall of the reaction chamber.

The best type of reaction chamber depends upon the pressure to be used. A welded, rectangular chamber with a flange for holding a thin, flat sheet seems best for pressures up to about 30 or 40 atmospheres. Its depth can be greater than the range of the energy used, which is about 0·2in of water for each million electron volt of mono-energetic beam. The optimum depth lies between that which makes the flow chamber so shallow that pressure drop becomes excessive, and that which is so much larger than the beam range that thorough mixing in the given reaction length is not obtained. The reactor can be

Fig. 13—3 MeV Van de Graaff particle accelerator, with tank removed

reduced in size from the piping to which it is connected by appropriate Venturi sections, as shown in the accompanying diagram. Appropriate pressure-relief points should, of course, be provided in the pressurised system, to prevent failure of the reaction-chamber window. Design data which have been calculated for one example of this reactor indicate that the beam-use efficiency is higher than 95 per cent at 2 MeV, or higher than 90 per cent at 1 MeV, for a pressure up to 35 atmospheres. A minimum flow rate is needed to produce turbulence during passage under the scanned beam. The amount of radiation dosage which is delivered during each pass depends on the beam power. If the power available is too low, a recycle flow system with a reservoir should be arranged, to maintain a high enough flow rate for turbulence. When fluids under pressure greater than 35 atmospheres are irradiated, it may be more convenient to use a tubular reactor in place of a flanged, welded chamber.

Titanium and aluminium tubes are both available with walls as thin as 0·005in, so that reasonably high efficiencies can be obtained at substantial pressures, even with 1 to 3 MeV electron beams. Aluminium tubes sized from ¼in to 2in diameter would probably allow working pressures up to about 75 atmospheres at 70 deg. Fah.

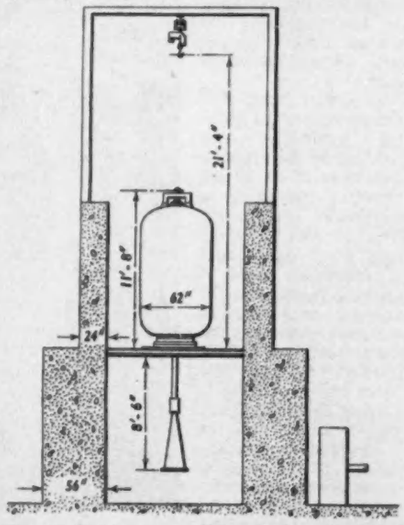


Fig. 14—Sectional elevation of Van de Graaff accelerator installation for electron-beam processing

Titanium, in sizes from $\frac{3}{16}$in to 1¼in diameter, would be most useful at pressures of 75 to 150 nospheres at 70 deg. Fah., or at half these .ssures at 500 deg. Fah. Hydrostatic bursting tests of titanium tubing have shown that the bursting pressure exceeds by 40 per cent the allowable working pressure calculated from published values of yield strength. Nevertheless, more conservative values than even the yield strengths by a factor of two have been used in all calculations.

Beam Power Output

The above review considered the electron-beam radiation output required for a given processing rate or, conversely, the production capacity of a given electron accelerator for any selected process. In cases where the product or its container cannot be changed, the minimum electron-beam energy will be fixed by the nature and thickness of the product to be treated, and by the technique to be used. Nevertheless, it is important to remember that for many applications, such as the irradiation of agitated fluid systems or of plastic film, beam energy is not critical. Here the energy used will usually be that for which available equipment gives the lowest cost per kilowatt-hour of electron-beam output.

The output of an accelerator can be expressed in kilowatts—the product of the beam energy in million electron volts and the beam current in milliamperes. Thus, a 3 MeV accelerator with a continuous beam-current output of 1mA is a 3kW radiation source. As indicated previously, 1 megarad corresponds to the absorption of

THE AMERICAN SCENE *(Continued)*

4·5kW-seconds of radiation in 1 lb of product. In more convenient terms : 1kW of electron-beam output can irradiate approximately 800 lb of product per hour to a dosage of 1 megarad if the absorption efficiency is 100 per cent.

It is also possible to express processing capacity in terms of an area, or linear rate, rather than in terms of weight. This approach is valid if the relationship of the average product thickness to the voltage is known. The basis for calculation is 1mA of beam current will deliver an average dose of 1 megarad to approximately 2400 square inches of product per minute, regardless of actual voltage, provided the thickness is two-thirds of the range for that voltage. At this thickness, the average dose is 85 per cent of the maximum dose.

In certain cases, it is merely desired to know the minimum dose received by the product, regardless of its shape, provided the beam is distributed uniformly over its area (as is the case when the product is conveyed under a scanned beam) and the voltage used ensures adequate penetration of the thickest part of the product. Here, the basis for calculation is 1mA of electron current will deliver a dose of 1 megarad to approximately 1700 square inches per minute of conveyor area. This will be the minimum dose to the material, regardless of voltage and efficiency, provided the thickest part of the product does not exceed two-thirds of the range for that voltage.

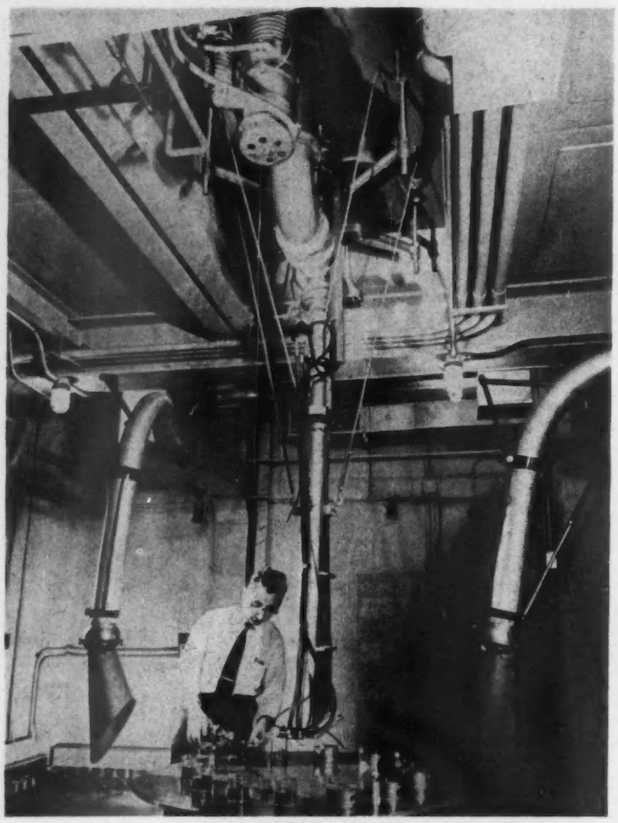


Fig. 15—3 MeV Van de Graaff accelerator with scanner for electron-beam processing installed at the Gulf Research and Development Company

When thin films are to be treated, it is convenient to know the linear speed at which a certain gauge and width can be processed to a given dose. As discussed previously, the efficiency for roll treatment or for a multi-pass system can be very high if the complete range of the beam is used. The sheet thickness used can be as high as about 20 per cent of the energy range, with uniform dosage achieved by integration of the depth profile. The rate that can be used is calculated from the available beam power on the following basis : 1kW will process 30,000ft per minute of film at 1 megarad if the film is 1in wide and 0·001in thick, with a specific gravity of 0·92, and if the overall efficiency of beam utilisation is 90 per cent.

Particle Accelerator Designs

The High Voltage Engineering Corporation now offers, in standardised designs, two different types of particle accelerators for processing—the Van de Graaff accelerator for energies between 1 MeV and 3 MeV, and the microwave linear accelerator for use in the energy range between 3 MeV and 15 MeV. The two types are radically different in operating principles. Briefly, the Van de Graaff unit develops its accelerating voltage by carrying electric charge to an insulated high-voltage terminal by means of a rapidly moving belt. The entire accelerating voltage thus developed is directly insulated by gas under pressure and is held constant by balancing the charge carried by the belt against the electron-beam current drawn from the terminal. The accompanying illustration shows the Van de Graaff electron accelerator and its major components in simplified cross-section.

The microwave linear accelerator, in contrast with the Van de Graaff, does not use very high voltages for accelerating particles. Instead, travelling waves of high-frequency microwave power are generated and directed down an evacuated waveguide. Bunches of electrons fired into the waveguide are trapped by the electromagnetic fields associated with these waves and are accelerated to the speed of the wave itself. An approximate analogy can be made to the surfboard rider being carried along on the crest of an ocean wave. In very general terms, the longer the waveguide, the greater the speed or energy of the electron beam produced.

The table below summarises the output characteristics of the standard accelerators now available for processing. The machines represent a very wide range of capabilities, both in terms of the thicknesses of product which can be penetrated and the amount of product which can be processed.

	Van de Graaff Machines		Linac Machines			
Model	GS	KS	LS–P–3	LS–P–5	LS–P–7	LS–P–9
Voltage, MeV	1·5	3	3	5	7	9
Current, milliamperes	1·67	1	2	1	0·6	0·33
Power, kW	2·5	3	6	5	4	3
Total range, inches of water	0·3	0·6	0·6	1·0	1·4	1·8
Processing capacity, 100 per cent (lb per hour per megarad)	2000	2400	4800	4000	3200	2400

Accelerator Installation

Particle accelerators are relatively compact and often can be installed in ordinary factory space without the need for a separate building, if adequate overhead room is available. However, provision must be made to protect personnel working in the vicinity of any particle accelerator from the dangerous radiation produced while the machine is in operation. In most cases, shielding against the electron beam is relatively simple. However, heavy walls are necessary around the target area for protection against the penetrating X-rays produced when the electrons strike metal or other heavy materials. Poured concrete or solid concrete block is most often used for the walls, and wall thicknesses generally run up to 7ft, depending on the voltage and power of the equipment involved. Therefore, it is advantageous to make use of some earth protection where possible.

Conveying a product through the target area in a continuous flow is a special problem, the solution of which depends on the nature of the material being processed. An installation with a conveyor layout is shown in the accompanying illustration. It is a general-purpose installation that permits the machine operator to load and unload the belt conveyor without leaving the accelerator-control station. By providing means for removing the section of the conveyor directly beneath the scanner, such special apparatus as reaction vessels or extruders can readily be used. To permit the observation of the target area, large mirrors may be set at turns in the conveyor system.

Van De Graaff Accelerator

The Model KS 3 MeV machine is representative of a Van de Graaff accelerator used for industrial processing work. It is a high-power machine, designed specifically for production line use and incorporating designs to obtain a high degree of ruggedness and reliability in hard usage. The major component of the accelerator proper is the voltage generator assembly, which is mounted on a steel baseplate and is contained in a pressurised steel housing. It consists of the power supplies, belt-drive motor and pulleys, charging belt, voltage-generating column and high-voltage terminal. The accompanying illustration shows this equipment with the tank removed.

The acceleration tube is of the multi-section, grounded-anode type, with its cathode assembly mounted at the high-voltage end. The evacuated extension system includes a high-speed mercury-diffusion pump with the necessary accessories. The extension system terminates with the beam scanner. The scanner comprises a pair of electromagnet coils, a steel vacuum chamber and a water-cooled, aluminium, cathode-ray window ¼in by 15in size.

A control console contains generator-voltage and beam-current meters, power and drive-motor switches, vacuum and electrical protectives, instruments for monitoring the vacuum in the accelerator-tube system, and the power supply and wave-form generator for driving the beam-scanner coils.

The accompanying diagram shows the principal dimensions of the machine arranged for electron-beam processing and also indicates the vertical clearance required for tank removal. An installation of a Model KS accelerator at the Gulf Research and Development Company is shown in the accompanying photograph.

(To be concluded)

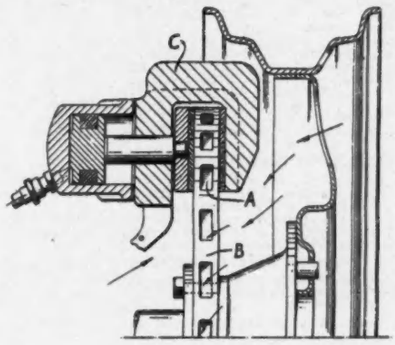
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

MOTOR VEHICLES

824,777. March 22, 1957.—Disc Brakes, Delta Motor Research, Ltd., Potton Manor, Potton, Bedfordshire. (*Inventor: Otto Anton von Smekal.*)

The present invention relates to disc brakes for motor vehicles. The invention provides that the friction disc is so constructed that a stream of cooling air passes through its interior. As shown in the



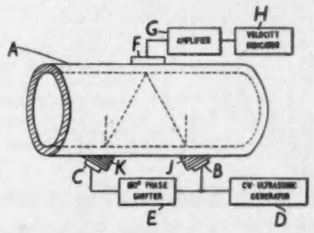
No. 824,777

drawing the disc is formed with passageways *A* extending generally radially from openings in the side walls to discharge ports spaced around the peripheral edge. The passageways are separated by ribs *B* which constitute impeller blades. On rotation of the disc the impeller blades force a stream of cooling air along the passageways to be discharged at the peripheral ports. By this design it is claimed that the cooling surface of the disc is considerably increased, being twice or more that of the outer surface of the disc. Furthermore, some of the cooling air is discharged to within the caliper *C* to pass around the flat brake shoe.—*December* 2, 1959.

ELECTRONICS

824,537. January 27, 1958.—Ultrasonic Flowmeter, William Edgar Pitt Bayly, The Plessey Company, Ltd., 56, Vicarage Lane, Ilford, Essex (communicated by Gulton Manufacturing Corporation, 212, Denham Avenue, Metachen, New Jersey, U.S.A.).

This invention relates to ultrasonic flowmeters and a principal object is to provide an ultrasonic flowmeter whose operation is independent of the fluid temperature. It is a further object to make operation depend only on the fluid velocity. In the drawing, *A* designates the pipe or fluid flow-



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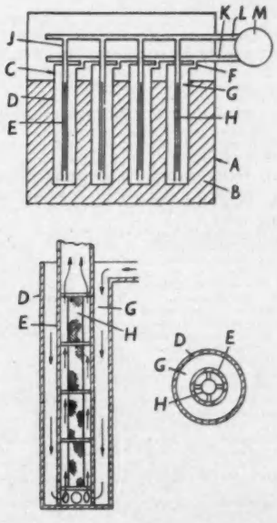
containing means in which the fluid flow velocity is to be measured. Transmitting transducers *B* and *C* are mounted on wedges so that the beam directions are correct. Ultrasonic generator *D* is used to excite *B* and *C* and phase shifter *E* is used to adjust the phase between them. Receiving transducer *F* receives and combines the signals from *B* and *C*, the resultant signal voltage from *F* is amplified by amplifier *G* and the corresponding fluid velocity is indicated on meter *H*. Transducers *A* and *B* are spaced from *F* so that the path lengths from each are equal. Wedges *J* and *K* serve to give proper direction to the beams within pipe *A*. If the two path lengths are identical, then the electrical signal drives to *B* and *C* should differ by 180 deg. and *B* and *C* should be matched, essentially identical transducers. When there is no fluid flow, the signals from *B* and *C* cancel at *F* because of the 180 deg. difference in phase in the signals applied to them and because of the equal path lengths. When there is fluid flow in *A*, the signals arriving at *F* will differ in phase. The phase shift is a function of the angle at which the sound beam crosses the tube, the geometry and the fluid flow velocity. This phase shift is not a function of the velocity of sound in the fluid and, consequently, is independent of the fluid temperature. The change in phase with fluid flow unbalances the cancellation at *F*, causing an electrical signal to be applied to amplifier *G* and resulting in an indication on *H* which may be a meter, oscilloscope or similar device calibrated in fluid flow so that the flow velocity may be read directly.—*December* 2, 1959.

NUCLEAR REACTORS

820,579. December 28, 1956.—Nuclear Reactors, C. A. Parsons and Co., Ltd., Heaton Works, Newcastle upon Tyne, 6, Northumberland.

The object of the present invention is to provide a liquid moderated nuclear reactor in which a liquid coolant can be used and in which the moderator can be kept below boiling point without the need for pressurising. In the example illustrated a nuclear



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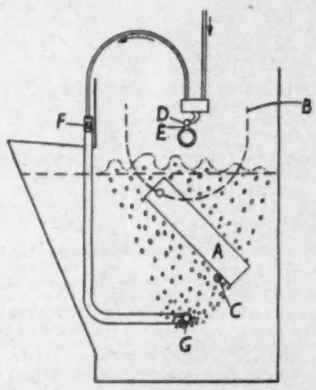
reactor comprises a vessel *A* containing a liquid moderator *B* such as heavy water. Disposed in the liquid moderator are re-entrant tubes *C*, each consisting of an outer tube *D* and an inner tube *E*. A cooling liquid is introduced at an inlet *F* to each tube *D* and this liquid flows downwards in an annular space *G* between the tube *D* and the tube *E* and then flows upwards through the tube *E* over fuel elements *H* which comprise containers housing nuclear fuel. After passing over the nuclear fuel the cooling liquid leaves the tube via an outlet *J*. In the preferred arrangement the liquid flowing in the space *G* is arranged to have a lower velocity than that flowing through the inside of tube *E*; as a result the heat transference from the fuel through the tubes to the moderator is reduced. The re-entrant tubes can be arranged in parallel with two supply mains *K* and *L* for the cooling fluid, the liquid being circulated through these mains by a pump *M*. The preferred cooling fluid is an organic fluid, for instance a fluid such as a diphenyl or a triphenyl. Heat transfer to the liquid moderator is kept at a level which prevents the boiling without the need for pressurising, because a relatively cool portion of coolant is always maintained between the part of the coolant flowing over the nuclear fuel and the liquid moderator. The tubes *D* may incorporate gas spaces to reduce the rate of heat transfer to the moderator. The liquid coolant can be circulated in a closed pressurised system.—*September* 23, 1959.

FILTERS

826,212. August 14, 1958.—Gas Filters, Vokes, Ltd., Henley Park, Guildford, Surrey. (*Inventors: John Cairns and Donald Frank Ringe.*)

One preferred constructional form of gas filter is described by way of example with reference to the accompanying drawing which is a side elevation of the lower part of a filter. A gas filter of the kind



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referred to employs an endless loop of filter panels *A* suspended for intermittent drive between a pair of sprocket chains *B*. An oil bath or trough is arranged in the lower part of the filter casing and a transverse bar *C* is provided to cant each filter panel as its upper end is driven round while fully immersed in the cleaning fluid. A roller *D* connected to an air valve is sited so as to be shifted by a cam *E* on the driving shaft as this shaft moves the chains to bring a panel into fully immersed position in the trough. The shifting of the roller *D* triggers the air valve and permits compressed air to flow to an air injector jet *F*. This jet is arranged within the mouth of an air supply pipe which is open to atmosphere at its upper end and is connected to an air discharge manifold *G* at its lower end. The injector jet induces an air flow from atmosphere to the discharge manifold and results in an economy of high pressure air from the main. The manifold has spaced holes in its lower surface through which air bubbles pour out and up through the filter panel to the liquid surface. This bubble flow effectively scours the panel and ensures thorough re-moistening of all surfaces.—*December* 31, 1959.

SEALS

826,176. February 21, 1958.—Impregnated Carbon Seals, D. Napier and Son, Ltd., 211, Acton Vale, London, W.3. (*Inventor: Donald Noel Hunter.*)

The invention relates to carbon seals of the kind used between two moving surfaces and to the impregnation of such seals to render them impervious in particular to hydrogen peroxide. It comprises impregnating a carbon body with an aqueous solution of phenol formaldehyde resin, the condensation of which has not been carried beyond the stage where the product remains soluble in water, and then curing the resin *in situ* by heat. The resin is thus of relatively low molecular weight such that it can satisfactorily impregnate the carbon. In a preferred method the phenol formaldehyde resin is that sold as "Bakelite R 568." A method of making a seal according to the invention comprises placing the carbon body in an air-tight container; applying a vacuum, drawing the impregnating resin into the chamber until the body is immersed whilst at the same time maintaining the vacuum; releasing the vacuum and pressurising the chamber, and finally heating the carbon body until the resin is fully cured. The vacuum applied is preferably of 5mm to 0·5mm of mercury which is maintained for at least five hours. The pressure applied after the vacuum is released is approximately 80 lb per square inch while this is maintained from one to two hours. The temperature when curing the resin is raised from 60 deg. to 150 deg. Cent. in 20 deg. Cent. steps at hourly intervals until the resin is fully cured. Equipment for carrying out this impregnation process is illustrated and described in the specification.—*December* 31, 1959.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Sat., Jan. 16.—ESSEX BRANCH: Visit to National Physical Laboratory, Teddington, 10 a.m.

Mon., Jan. 18.—BRISTOL AND WEST OF ENGLAND BRANCH: Grand Hotel, Bristol, "Escalators," R. E. Landsbert, 8 p.m.

Tues., Jan. 19.—ALDERSHOT AND DISTRICTS BRANCH: Queens Hotel, South Farnborough, Hants, "Your Water Supply," R. Irvine-Hudson, 7.30 p.m. ★ LONDON NATIONAL LECTURE: Manson House, 26, Portland Place, London, W.1, "The Electrical Association for Women," Miss Mary George, 6.30 p.m. ★ OXFORD AND DISTRICTS BRANCH: Employment Exchange, Oxford, "Infra-Red Heating," 7.30 p.m.

Wed., Jan. 20.—NOTTINGHAM BRANCH: E.M.E.B. Showroom Theatre, Carrington Street, Nottingham Open Forum, "The Future Trend of Technical Education," 7.30 p.m. ★ WOLVERHAMPTON AND DISTRICT BRANCH: Chamber of Commerce, District Bank Chambers, Lichfield Street, Wolverhampton, "A.C. Motor Control Gear," S. H. Harding, 7.45 p.m.

Fri., Jan. 22.—STOKE AND CREWE BRANCH: Royal Hotel, Crewe, "Earthing and Earth Leakage Protection of Electrical Installations," J. A. Robbins, 7.30 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Thurs., Jan. 21.—SCOTTISH SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Micro Miniaturization," H. G. Manfield, 7 p.m.

Fri., Jan. 22.—SCOTTISH SECTION: Department of Natural Philosophy, The University, Drummond Street, Edinburgh, "Micro Miniaturization," H. G. Manfield, 7 p.m.

BRITISH INTERPLANETARY SOCIETY

Sat., Jan. 16.—SCHOOLS LECTURE: Hoare Memorial Hall, Church House, London, S.W.1, "The Scientific Exploration of Space," N. H. Langton, 3 p.m.

CEMENT AND CONCRETE ASSOCIATION

Fri. to Thurs., Jan. 15 *to* 21.—Great Hall, Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1, Prestressed Concrete Exhibition, 10 a.m. to 6 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Thurs., Jan. 21.—MIDLAND REGION: Chamber of Commerce, New Street, Birmingham, "The Case For, and the Maintenance of, Mechanical Stokers," H. E. Pearsall, 10.15 a.m.

DIESEL ENGINEERS AND USERS' ASSOCIATION

Thurs., Jan. 21.—Institute of Marine Engineers, Mark Lane, London, E.C.3, "Oil Engine Driven Pumping Plant," P. F. Morgan, 2.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

Tues., Jan. 19.—HULL CENTRE: Lecture Theatre, Yorkshire Electricity Board, Ferensway, Hull, "Lighting for Ships," P. Chittenden, 6.30 p.m. ★ LIVERPOOL CENTRE: Merseyside and N. Wales Electricity Board Industrial Development Centre, Liverpool, "Lighting, and Other Things, in Moscow and Leningrad," A. G. Penny, 6 p.m. ★ NORTH LANCASHIRE GROUP: Demonstration Theatre, North Western Electricity Board, 19, Friargate, Preston, "Lighting of the Niagara Falls," D. J. Reed, 7 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Mon., Jan. 18.—EAST ANGLIAN SECTION: Lecture Hall, Public Library, Ipswich, "Production of Foundry Sands," A. R. Abraham, 7.30 p.m.

Tues., Jan. 19.—SLOUGH SECTION: Lecture Theatre, High Duty Alloys, Ltd., Slough, "Special Copper-Case Alloys," A. R. French and A. W. O. Webb, 7.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Mon., Jan. 18.—WEST OF ENGLAND SECTION: Smith's Assembly Rooms, Bath, "Research and Failures of Metals in Service," C. E. Phillips, and A. C. Low, 7.30 p.m.

INSTITUTE OF NAVIGATION

To-day, Jan. 15.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Heading Definition in Commercial Aircraft," J. F. Green and A. P. Glenny, 5.15 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Tues., Jan. 19.—NORTH EASTERN CENTRE: Three Tuns Hotel, Durham City, Film, "Wheels Round the World," and Talk, N. L. Eden-Smith, 7.30 p.m.

Wed., Jan. 20.—EASTERN CENTRE: Davey Paxman and Co., Ltd., Colchester, "Unusual Types of Trailer and Air Suspension," J. L. B. Crane, 7 p.m.

Thurs., Jan. 21.—METROPOLITAN AREA: Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, "Air Suspension," V. E. Gough, 6.30 p.m. ★ YORKSHIRE CENTRE: Great Northern Hotel, Wellington Street, Leeds, 1, "Transport Developments in U.S.A., 1957," John F. Moon, 7.30 p.m.

INSTITUTE OF WELDING

Wed., Jan. 20.—NORTH LONDON BRANCH: 54, Princes Gate, London, S.W.7, "Further Developments in the Welding of Atomic Plant," A. Prince, 7.30 p.m.

INSTITUTION OF AGRICULTURAL ENGINEERS

Mon., Jan. 18.—NORTHERN CENTRE: N.E. Electricity Board's Lecture Theatre, Carliol House, Newcastle upon Tyne, "Compaction of Soil by Cultivation Operations," E. R. Fountaine, 6.45 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Wed., Jan. 20.—NORTH WESTERN BRANCH: Lecture Theatre A, The Houldsworth School of Applied Science, The University, Leeds, 2, "Refrigeration Practice," Mr. Perry, 6.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Jan. 19.—Great George Street, Westminster, London, S.W.1, "Sanitary Engineering in Germany," F. Pöpel, 5.30 p.m.

Thurs., Jan. 21.—TRAFFIC ENGINEERING STUDY GROUP: Great George Street, Westminster, London, S.W.1, Discussion on "The Development of Traffic Engineering in London," introduced by A. J. H. Clayton, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, Jan. 15.—NORTH SCOTLAND SUB-CENTRE: Robert Gordon's Technical College, Aberdeen, "The 'Deltic' Locomotive," C. M. Cock, 7.30 p.m.

Mon., Jan. 18.—INFORMAL MEETING: Savoy Place, London, W.C.2, Discussion on "The Reliability and Economy of Cable Installation," opened by W. Holttum, 5.30 p.m. ★ MERSEY AND NORTH WALES CENTRE: Donnan Laboratories, Vine Street, Liverpool, "Radio Aspects of the International Geophysical Year," R. L. Smith-Rose, 6.30 p.m. ★ NORTH-EASTERN MEASUREMENT AND ELECTRONICS GROUP: Rutherford College of Technology, Newcastle upon Tyne, 1, "Electrical Uses of Atomic Spin," G. Phillips, 6.15 p.m. ★ NORTH STAFFORDSHIRE SUB-CENTRE: Technical College, Stafford, "The Selection of Insulation Levels and Tests for High-Voltage Transformers," G. B. Harper, 7 p.m. ★ WESTERN SUPPLY GROUP: South Wales Institute of Engineers, Park Place, Cardiff, "The Design of Electro-Mechanical Auxiliaries Directly Associated with Power-Producing Reactors," A. E. Harwood, P. Scott and B. H. Stonehouse, 6 p.m. ★ READING DISTRICT BRANCH: George Hotel, King Street, Reading, "Safety in the Use of Electricity in the Factory and in the Home," S. J. Emerson, 7.15 p.m.

Tues., Jan. 19.—MEASUREMENT AND CONTROL SECTION: Savoy Place, London, W.C.2, Discussion on "Superseding the Ratio Arms in A.C. Bridges," opened by C. G. Mayo, 5.30 p.m. ★ NORTH-WESTERN MEASUREMENT AND CONTROL GROUP: Engineers' Club, Albert Square, Manchester, "Examples of Geoelectric Surveys," L. S. Palmer, 6.15 p.m. ★ SOUTH-EAST SCOTLAND SUB-CENTRE: Carlton Hotel, North Bridge, Edinburgh, "Generator/Motor Problems in Pumped-Storage Installations," J. H. Walker, 7 p.m.

Wed., Jan. 20.—EDUCATION DISCUSSION CIRCLE: Savoy Place, London, W.C.2, Discussion on "One Approach to Generalised Machine Analysis," opened by J. G. Henderson, 6 p.m. SHEFFIELD SUB-CENTRE: Grand Hotel, Sheffield, "The Influence of Consumers' Load/Consumption Characteristics on Metering Practice," L. B. S. Golds, 6.30 p.m. ★ SOUTH-WEST SCOTLAND SUB-CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "Subscriber Trunk Dialling," D. A. Barron, 6 p.m. ★ RUGBY SUB-CENTRE: College of Technology and Arts, Rugby, "New Developments in Electrical Machines," G. H. Rawcliffe, 6.30 p.m. ★ SOUTHERN CENTRE: The University, Southampton, Joint Meeting with the Southern Association of the Institution of Civil Engineers, "The Provision of Adequate Electrical Installations in Buildings—Commercial Buildings," E. E. Jacobi, 7 p.m. ★ OXFORD DISTRICT BRANCH: Southern Electricity Board Service Centre, 37 George Street, Oxford "Electrical Installation Practice" E. J. Sutton, 7 p.m.

Wed. to Thurs., Jan. 20 *to* 21.—MEASUREMENT AND CONTROL SECTION IN CO-OPERATION WITH THE BRITISH COMPUTER SOCIETY: Savoy Place, London, W.C.2, Discussion Meetings on "Managerial and Engineering Aspects of Reliability and Maintenance of Computer Systems," 5.30 p.m.

Thurs., Jan. 21.—NORTH MIDLAND CENTRE: Y.E.B. Offices, Ferensway, Hull, Joint Meeting with the Graduate and Student Section, "Domestic Electricity," D. Hardy, 6.30 p.m. ★ WESTERN CENTRE: Sophia Gardens Pavilion, Cardiff, Faraday Lecture, "Electrical Machines," M. G. Say, 6 p.m. ★ SOUTH-WESTERN SUB-CENTRE: Plymouth "B" Generating Station, Prince Rock, Plymouth, "The 'Deltic' Locomotive," C. M. Cock, 3 p.m. ★ IRISH BRANCH: Physical Laboratory, Trinity College, Dublin, "The Place of Electricity in Irish Agriculture," J. F. Bourke, and M. Shiels, 6 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Wed., Jan. 20.—YORKSHIRE BRANCH: Midland Hotel, Bradford, "The Architect, Designer and Practitioner," M. G. Riley, 7.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Jan. 19.—39, Elmbank Crescent, Glasgow, "The Impact of Air Conditioning on the Ship Designer," 6.30 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

Fri., Jan. 22.—NORTHERN BRANCH: The Courts, Carlisle, "Dry-lean Concrete—Theory and Practice" D. R. Sharp and J. M. Fisher 6.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Tues., Jan. 19.—Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, "Some Aspects of Railway Braking," R. C. S. Low, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Jan. 15.—SCOTTISH BRANCH: North British Hotel, Edinburgh, "Nuclear Power, Past, Present and Near Future," J. Diamond, 6.30 p.m.

Sat., Jan. 16.—LONDON GRADUATES' SECTION: 1, Birdcage Walk, Westminster, London, S.W.1, "The Future of the High-Speed Reciprocating Internal Combustion Engine," J. H. Pitchford, 3 p.m.

Tues. to Jan. 19.—SOUTH WALES BRANCH: King's Head Hotel, Newport, "Special and Alloy Iron Castings in Mechanical Engineering," A. B. Everest, 6 p.m. ★ EASTERN GRADUATES' SECTION: Afternoon visit to Britannia Iron Foundry, Bedford.

Wed., Jan. 20.—ORDINARY MEETING IN CONJUNCTION WITH THE INTERNAL COMBUSTION ENGINE GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, "The Diesel Engine in Association with the Gas Turbine," E. E. Chatterton, 6 p.m. ★ EAST MIDLANDS BRANCH: Room 104, College of Technology and Commerce, Leicester, "Atomic Energy Factories: Design and Construction Problems," H. V. Disney, 7.15 p.m.

Thurs., Jan. 21.—HYDRAULICS GROUP DISCUSSION: 1, Birdcage Walk, Westminster, London, S.W.1, "The Value of Hydraulics Research in Mechanical Engineering," 6 p.m. ★ EASTERN BRANCH: Gaumont Restaurant, Northampton, "Engineering Aspects of the Design of Fighting Vehicles," J. L. Thompson, 7.30 p.m. ★ EASTERN GRADUATES' SECTION: Visit to G.P.O. Telephone Exchange, Oxford, 7.30 p.m. ★ EAST MIDLANDS GRADUATES' SECTION: Technical College, Lincoln, "Increased Operating Temperatures for Jet Aero-Engines," J. C. Adderley, 7.15 p.m. ★ YORKSHIRE BRANCH: Hotel Metropole, Leeds, "Power Production Plant," M. J. Hillas, 6.30 p.m.

INSTITUTION OF MINING AND METALLURGY

Thurs., Jan. 21.—Geological Society, Burlington House, Piccadilly, London, W.1, "Serial Gravity Concentration: A New Tool in Mineral Processing," J. H. Harris; and "Use of Moving Bed Ion Exchange in the Recovery of Uranium at Can-Met Explorations, Ltd., Blind River, Ontario," P. D. R. Maltby, 5 p.m.

INSTITUTION OF PLANT ENGINEERS

Mon., Jan. 18.—Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, "The Engineering Problems Anticipated in Space Travel," M. J. Brennan, 7 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

To-day, Jan. 15.—EASTERN REGION: Golden Lion Hotel, Cornhill, Ipswich, "The Contribution of Epoxide Tooling to Engineering," E. M. White, 7.30 p.m.

Mon., Jan. 18.—NORTH MIDLANDS REGION: Louis Room, St. James's Restaurant, St. James's Street, Derby, "Production of the A.W.A. 'Argosy' Aircraft," R. A. Courtman, 7 p.m.

Wed., Jan. 20.—MIDLANDS REGION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Comet Aircraft Production," A. W. Turner, 7 p.m. ★ WOLVERHAMPTON GRADUATE SECTION: Wolverhampton and Staffs College of Technology, Wulfruna Street, Wolverhampton, "Powder Metallurgy—Its Application to the Production of Engineering Components, and its Advantages and Limitations," P. R. Marshall, 7 p.m. ★ MIDLANDS REGION: Star Hotel, Worcester, "Modern Aspects of Diecasting," A. E. Fenn, 7.30 p.m. ★ LONDON GRADUATE SECTION: 10, Chesterfield Street, Mayfair, London, W.1, "Let the Process Speak for Itself," P. A. Daisley, 7.15 p.m. ★ SOUTH EASTERN REGION: Hoffmann Manufacturing Company, Ltd., Social Centre, Chelmsford, "Incentives," D. B. A. Brasier-Creagh, 7.30 p.m.

Thurs., Jan. 21.—NORTHERN IRELAND REGION: Kensington Hotel, Belfast, "Training for Management," N. Rimmer, 7.30 p.m. ★ SCOTTISH REGION: Royal College of Science and Technology, Room M.405, Glasgow, "Training for General Management," P. Hanika, 7.30 p.m. ★ SOUTH EASTERN REGION: Royal Commonwealth Society, Northumberland Avenue, Strand, London, W.C.2, "The Place of the Consultant in Industry," A. D. Wilson, 7 p.m. ★ SOUTHERN REGION: Polygon Hotel, Southampton, "Piston Production," G. Longfoot, 7.15 p.m. ★ WALES REGION: Glamorgan College of Technology, Treforest, Glamorgan, "Production by Powder Metallurgy," B. H. Swan, 7 p.m.

INSTITUTION OF THE RUBBER INDUSTRY

Mon., Jan. 25.—MANCHESTER SECTION: Newton Heath Technical College, Manchester, "Developments in the Preservation and Testing of Latex," M. W. Philpott, 6 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

To-day, Jan. 15.—MIDLAND COUNTIES BRANCH GRADUATES' AND STUDENTS' SECTION: Birmingham Exchange and Engineering Centre, Birmingham, "Extension to the Isle of Grain, Kent Refinery for British Petroleum Company, Ltd.," R. Adams, 6.30 p.m.

Mon., Jan. 18.—NORTHERN IRELAND BRANCH: Queen's University, Belfast, "The Design and Construction of the Speiga Dam," F. F. Poshitt and J. A. Soya, 6.30 p.m.

Tues., Jan. 19.—LANCASHIRE AND CHESHIRE BRANCH: College of Science and Technology, Manchester, "Berkeley Power Station," D. R. R. Dick, 6.30 p.m. ★ SCOTTISH BRANCH: Institution of Engineers and Shipbuilders, Glasgow, "The Relationship between Architect and Structural Engineer," W. Underwood, 7 p.m.

Wed., Jan. 20.—WALES AND MONMOUTHSHIRE BRANCH: Mackworth Hotel, Swansea, "The Reconstruction of Swansea Market," 6.30 p.m. ★ YORKSHIRE BRANCH: Metropole Hotel, Leeds, "Modern Large Span Suspension Bridges" O. A. Kerensky 6.30 p.m.

Thurs., Jan. 21.—LONDON BRANCH: 11, Upper Belgrave Street, London, S.W.1, "Lightweight Fire Protection and the Structural Engineer," A. R. Mackay, 6 p.m. ★ NORTHERN COUNTIES BRANCH: 6, Higham Place, Newcastle, "Landscape and People," M. J. Earley, 7.30 p.m.

Fri., Jan. 22.—MIDLAND COUNTIES BRANCH: James Watt Memorial Institute, Birmingham, "Modern Methods of Fabricating Structural Steelwork," M. F. Palmer and R. J. Fowler, 6.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Jan. 15.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "A Radio Navigation Aid for Ships and Aircraft," C. Powell, 7 p.m.

Fri., Jan. 22.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Developments in Engineering Education, Recently and to Come," H. L. Haslegrave, 7 p.m.

LIVERPOOL METALLURGICAL SOCIETY

Thurs., Jan. 21.—Department of Metallurgy, The University, 146, Brownlow Hill, Liverpool, 3, "Student Prize Competition," 7 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS

To-day, Jan. 15.—Engineers' Club, Albert Square, Manchester, 2, "Aircraft Blind Landing Systems," J. S. Shayler, 6.45 p.m.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

To-day, Jan. 15.—Lecture Theatre, Mining Institute, Neville Hall, Newcastle upon Tyne, "Off-Shore Drilling Barges," W. Pratt and W. A. Roy, 6.15 p.m.

PLASTICS INSTITUTE

To-day, Jan. 15.—MIDLANDS SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, 3, "Plastics in Electronics," H. A. K. Eden, 6.30 p.m.

Tues., Jan. 19.—LONDON AND DISTRICT SECTION: Wellcome Building, 183–193, Euston Road London, N.W.1, "Plastics in the Packaging Industry," G. Swift, 6.30 p.m.

Wed., Jan. 20.—NORTH-EASTERN SECTION: Second Dining Room, Eldon Grill, Grey Street, Newcastle, "Chromatographic Analysis," M. Rutter, 7 p.m. ★ WESTERN SECTION: Wheatstone Hall, Gloucester, "Plastics in the Automobile Industry," A. C. Hill, 7 p.m.

REINFORCED CONCRETE ASSOCIATION

Tues., Jan. 19.—SCOTTISH BRANCH: St. Enoch Hotel, Glasgow, "Recent Development Work on Clydeside Shipyards," W. G. N. Geddes, 6.30 p.m.

Thurs., Jan. 21.—WEST OF ENGLAND BRANCH: New School of Engineering, The University, Bristol, "Methods and Plant for Concrete," A. B. Harman, 6 p.m.

ROYAL METEOROLOGICAL SOCIETY

Wed., Jan. 20.—49, Cromwell Road, London, S.W.7, "Experimental Studies of Wave-form Clouds," N. Gerbier, and "Recent Developments in Theoretical Treatment of Mountain Waves," E. Palm, 5 p.m.

Fri., Jan. 22.—MANCHESTER CENTRE: The University, Manchester, "Evaporation from the Oceans and from Lakes," J. L. H. Sibbons, 5.45 p.m.

ROYAL SOCIETY OF ARTS

Wed., Jan. 20.—John Adam Street, Adelphi, London, W.C.2, "The Function of Management in Industry and Commerce," Sir Frederic Hooper, 2.30 p.m.

ROYAL STATISTICAL SOCIETY

Wed., Jan. 20.—London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, "Statistics of the Transport of Goods by Road," K. F. Glover, 5.15 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Thurs., Jan. 21.—Battersea College of Technology, Battersea Park Road, London, S.W.11, Conversazione, 6.30 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

To-day, Jan. 15.—39, Elmbank Crescent, Glasgow, Joint Meeting with the Iron and Steel Institute, Engineers' Group, "Engineering Aspects of a Modern Open-Hearth Steel Plant," J. A. Kilby and J. C. Gordon, 6.45 p.m.

Advanced Engineering Courses

Management Practice and the System Analyst. MANAGEMENT TRAINING (P.E.), LTD., TRAINING DIVISION OF PRODUCTION-ENGINEERING, Ltd., 12, Grosvenor Place, London, S.W.1. A six-week course beginning on February 1, in using computers. Five main subjects will be covered: (1) Management Organisation and the Control of Production; (2) The Analytical Study of Work; (3) Financial and Management Accounting; (4) Office Administration; (5) Computers and their Associated Problems. Nominations should be sent to the Course Secretary, Management Training (P.E.), Ltd., Park House, Wick Road, Egham, Surrey. Fee 185 guineas (non-residential).

Some Basic Engineering Problems in Tidal Estuaries. UNIVERSITY OF LONDON, Senate House, Russell Square, London, W.C.1. A course of three lectures by Professor A. T. Ippen. "Tidedynamics in Estuaries," "Diffusion and Energy Dissipation in Estuaries," and "Sediment Problems in Estuaries." February 8, 10 and 12, at 5.30 p.m. Admission free.

Radiation Protection. SOUTH-EAST ESSEX TECHNICAL COLLEGE, Longbridge Road, Dagenham. A course of twelve lectures to be held on Mondays from 7 to 9 p.m., commencing Monday, January 25. Fee £1 15s., plus 1s. College membership fee.

Engineering Aspects of Spaceflight. Post-Advanced Lectures in Mechanical Engineering. ROYAL TECHNICAL COLLEGE, Salford. A course of twelve lectures, Tuesdays 7 to 9 p.m., commencing Tuesday, January 19. Fee £2 2s.

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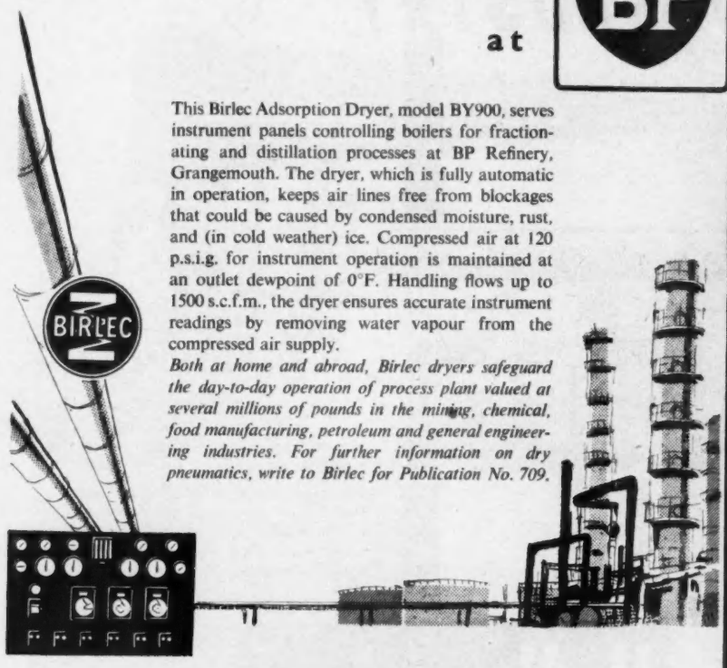

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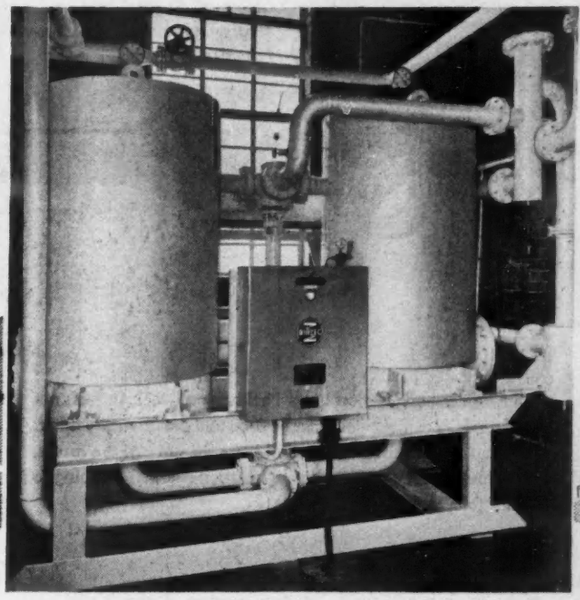

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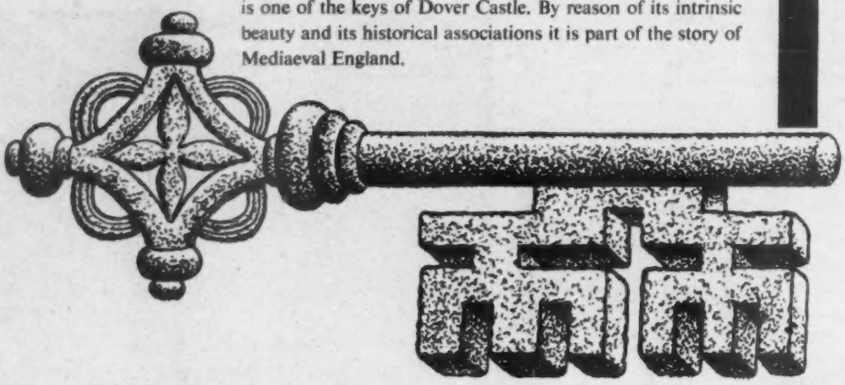

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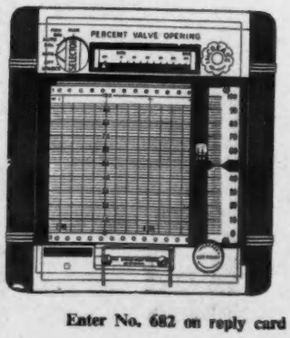

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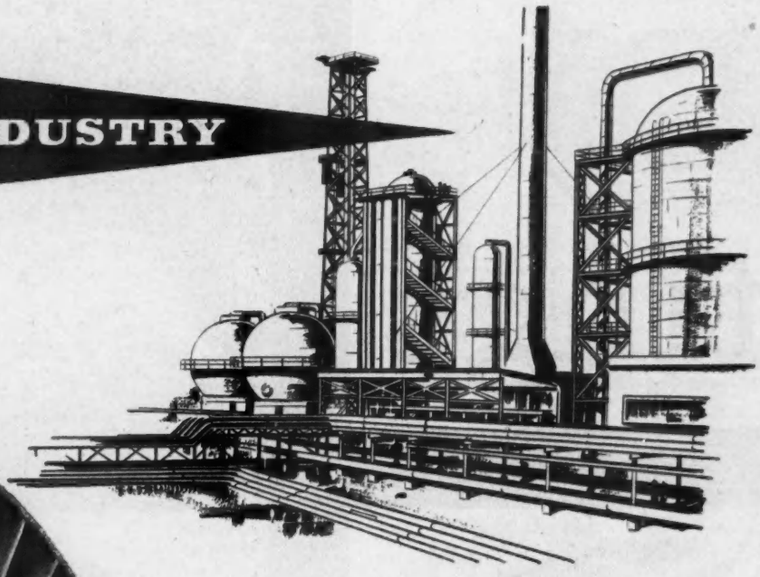

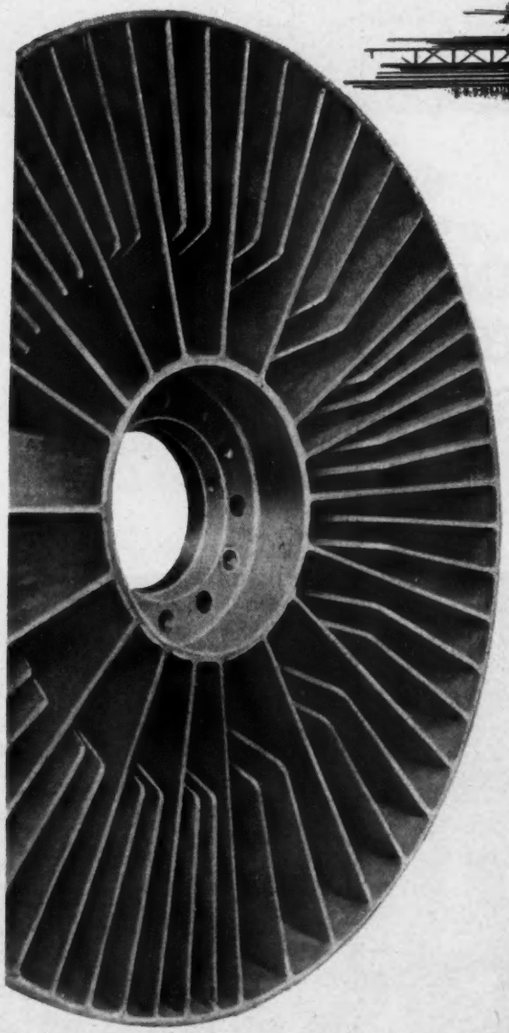

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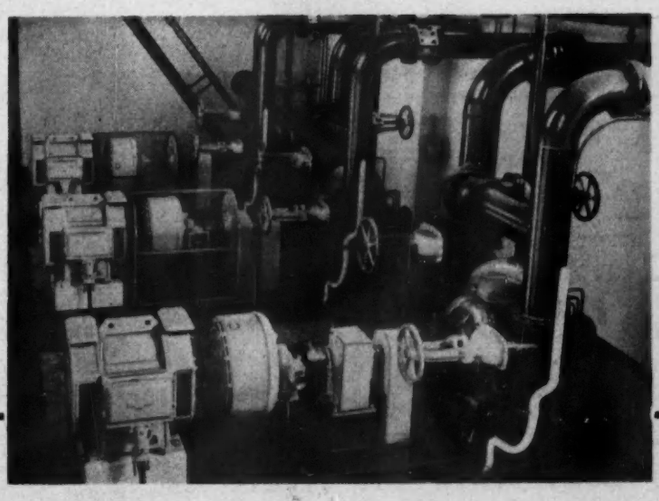

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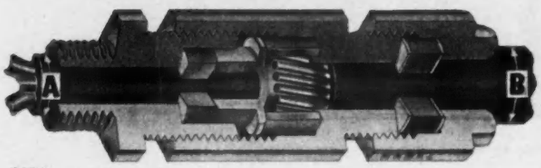

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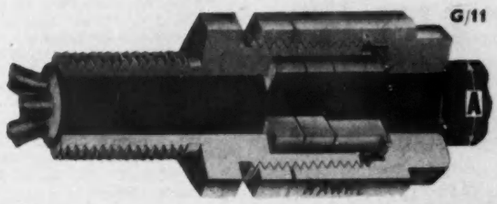

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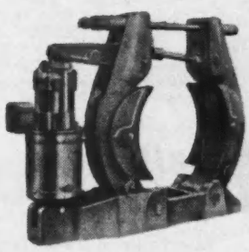

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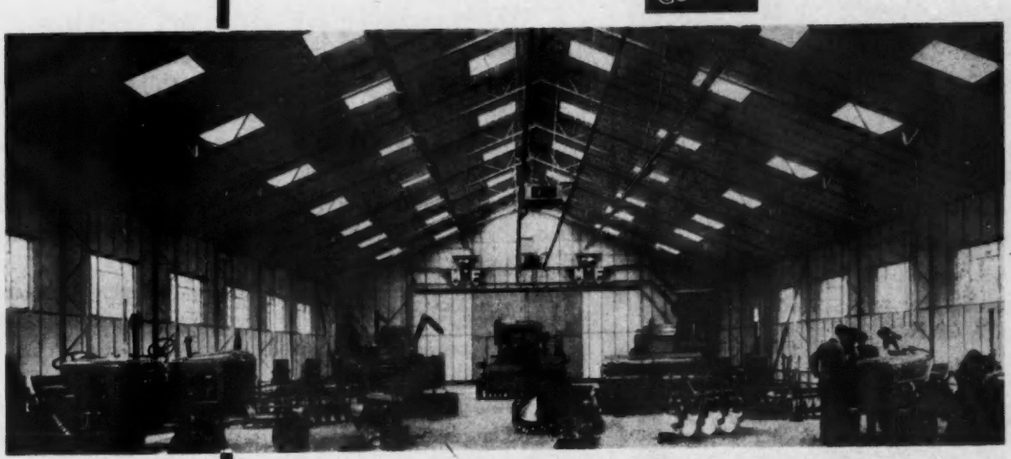

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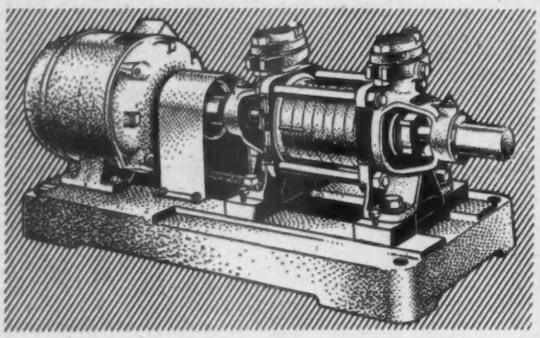

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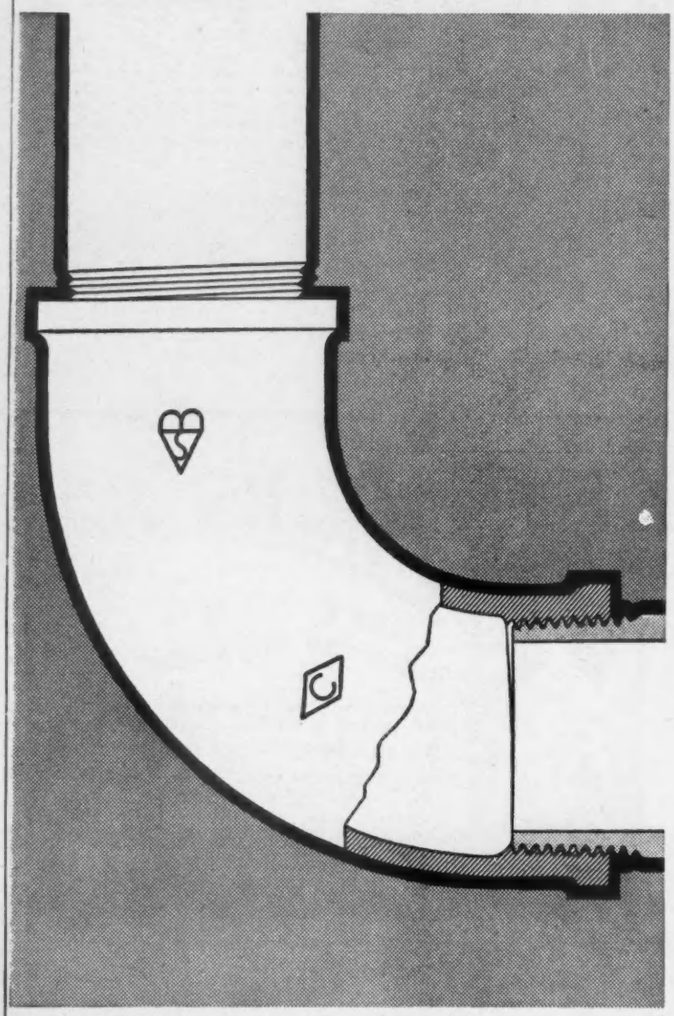

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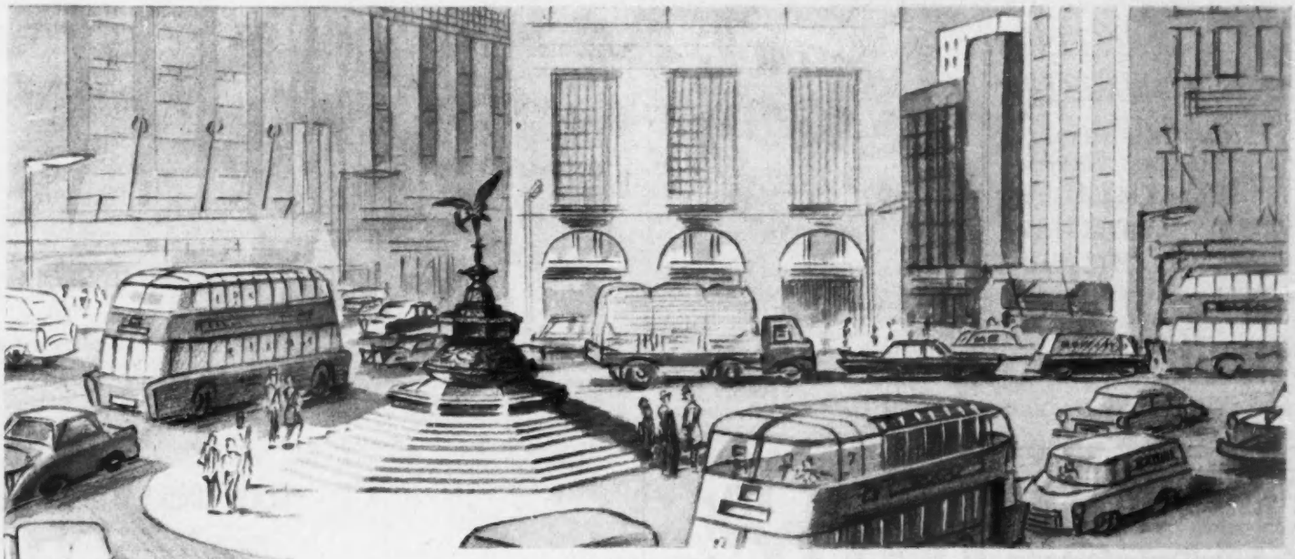

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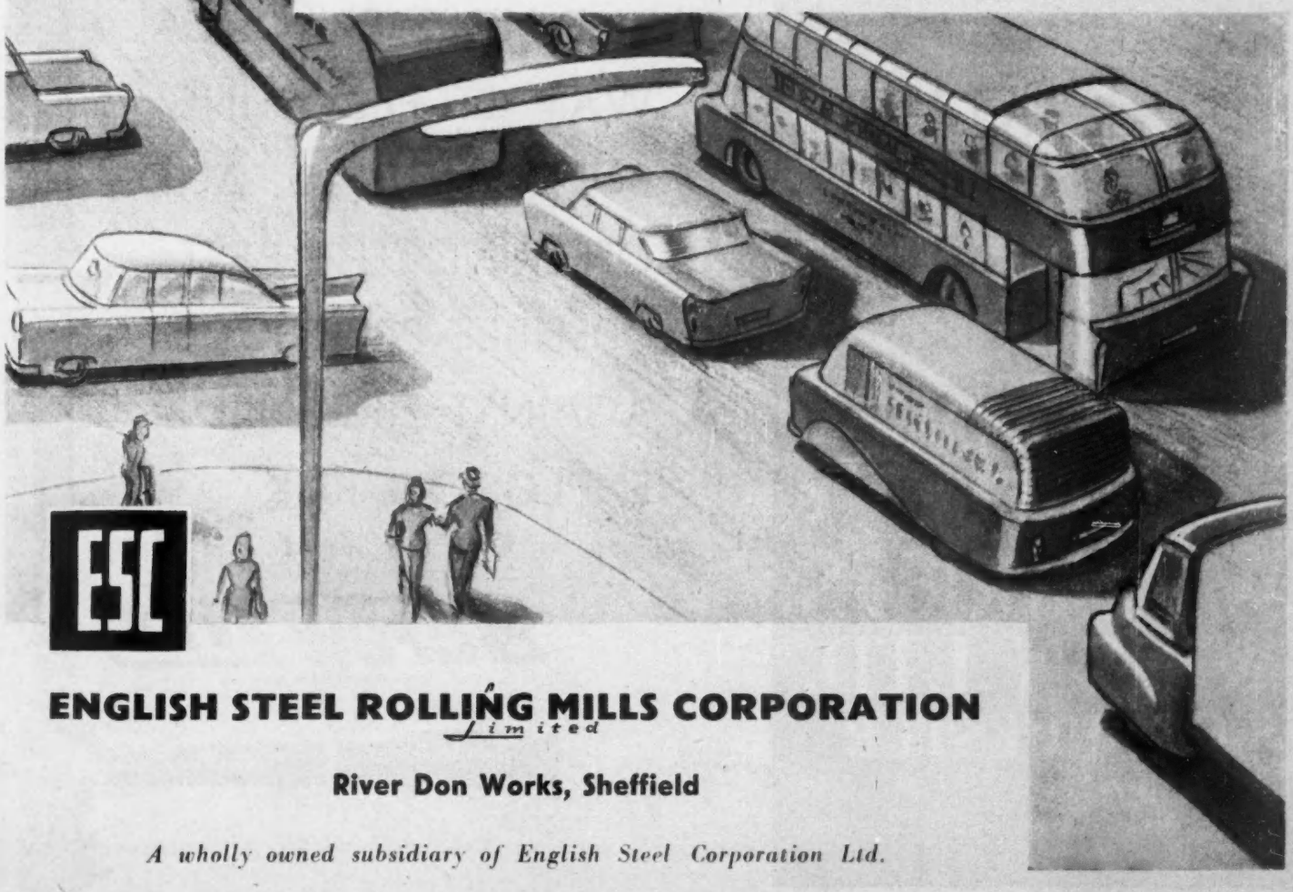

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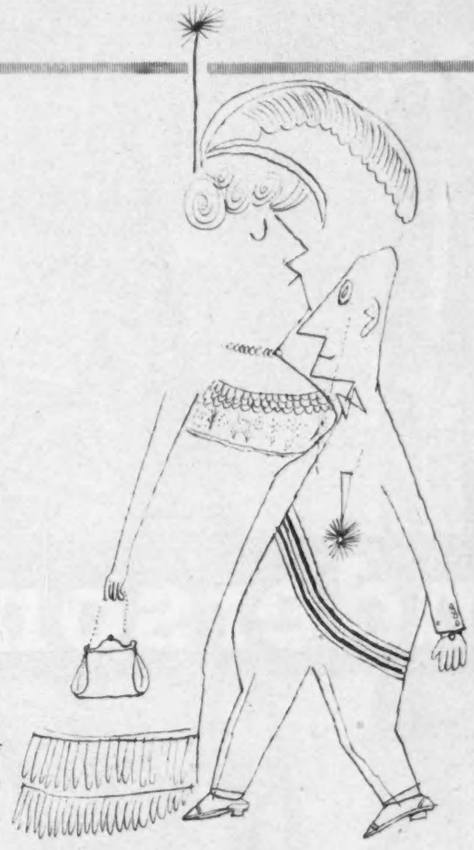

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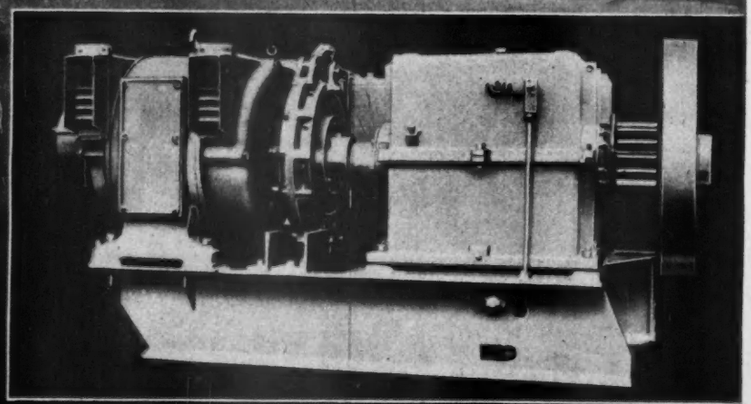

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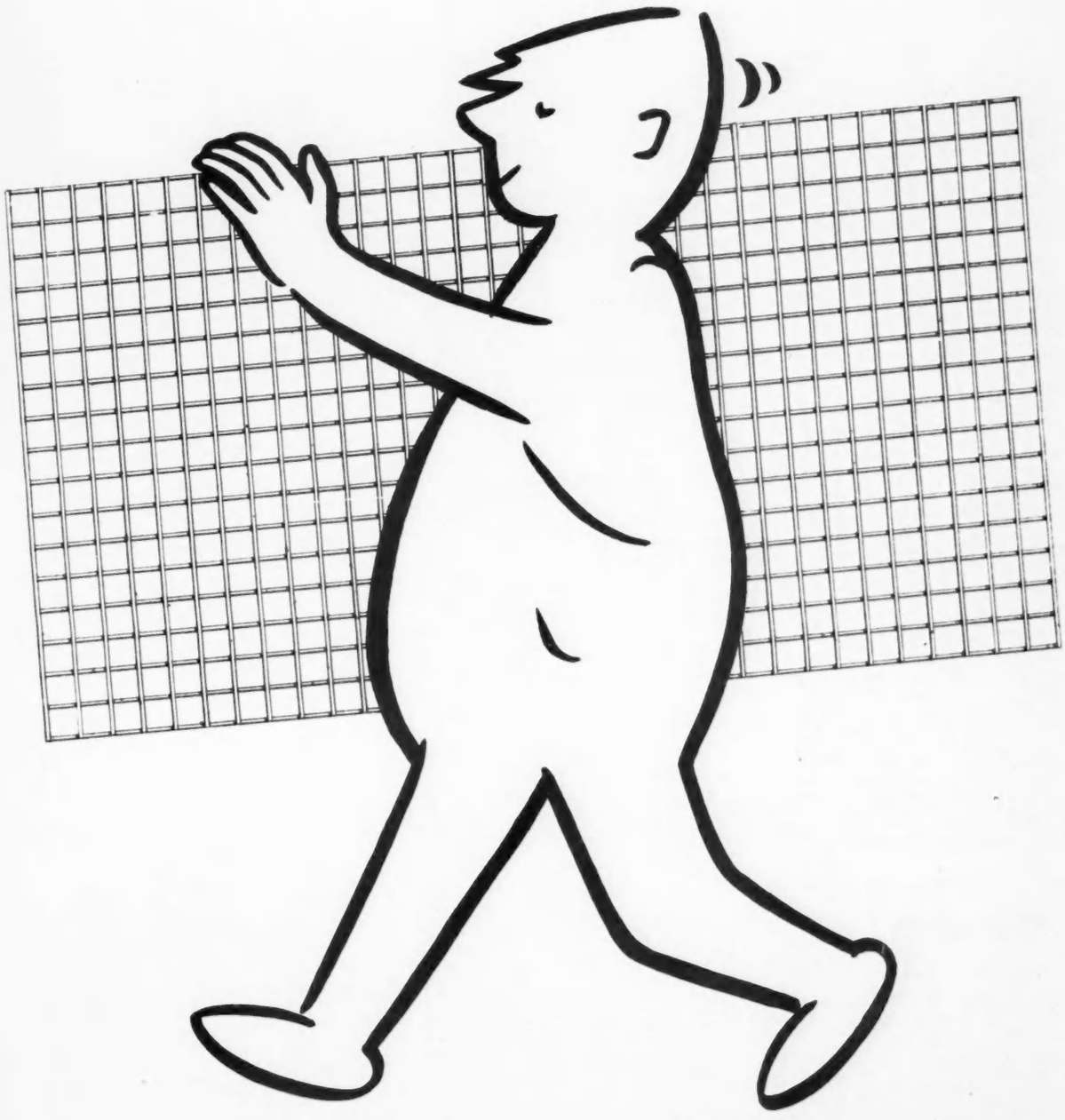

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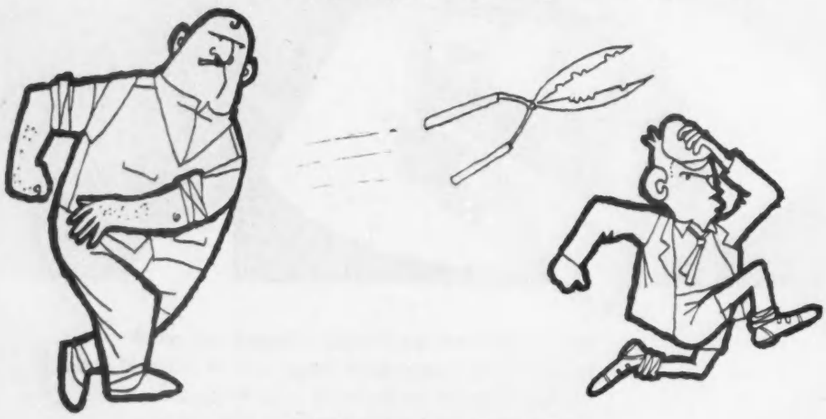

High sustained speeds of working can be achieved, such as in the case of a 6-Stand Billet Mill, whose product is cut continuously at the full mill delivery speed of 600 feet per minute. In just one of those minutes anything from 20 to 40 cuts may be made—flying times indeed.

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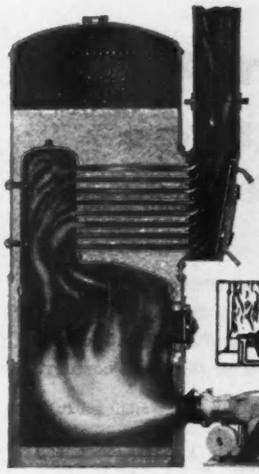

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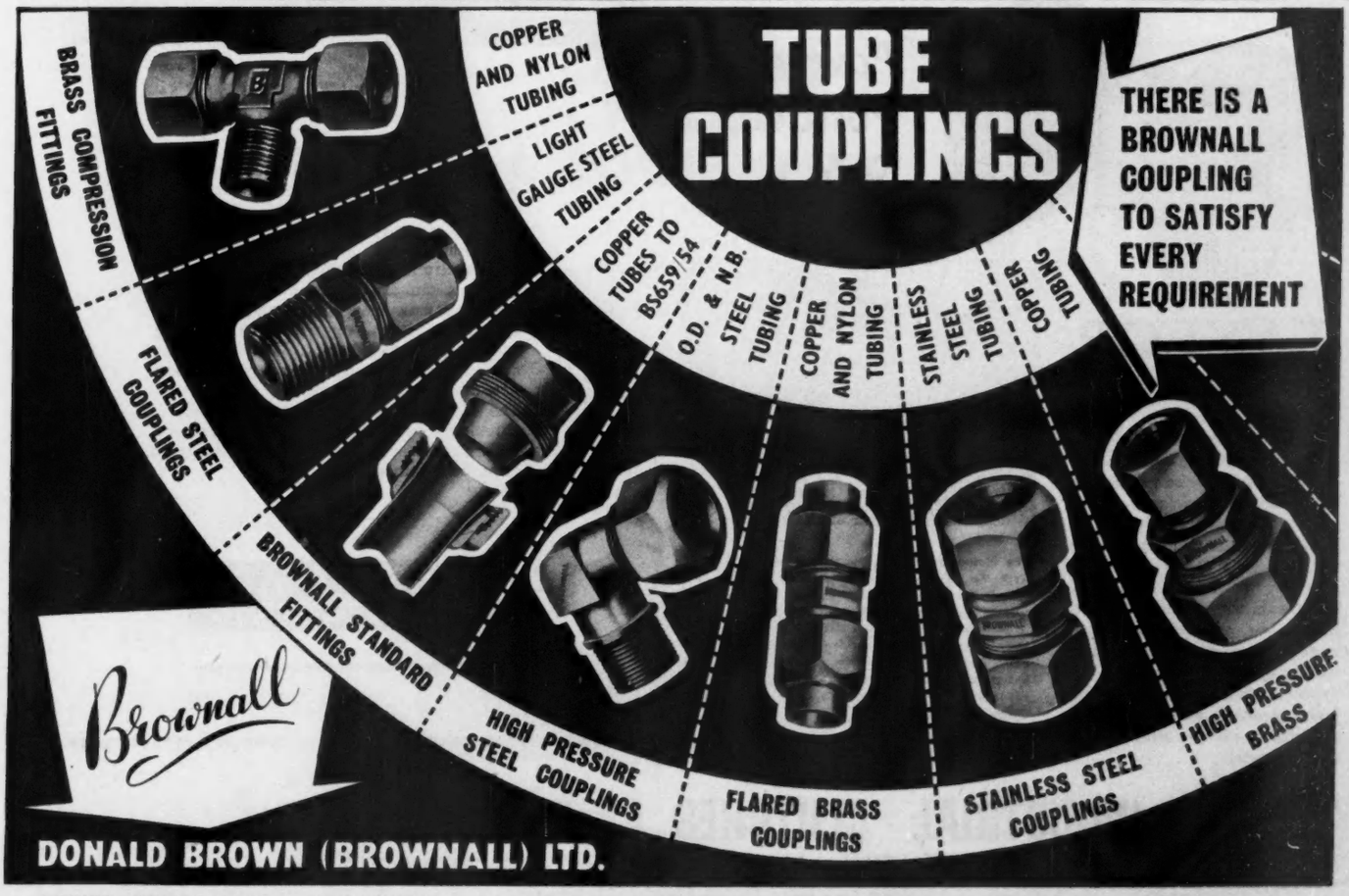

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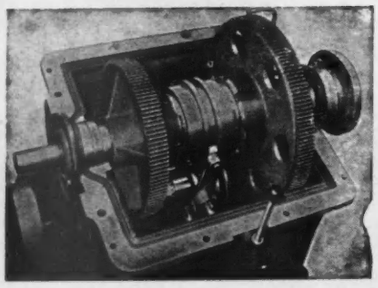

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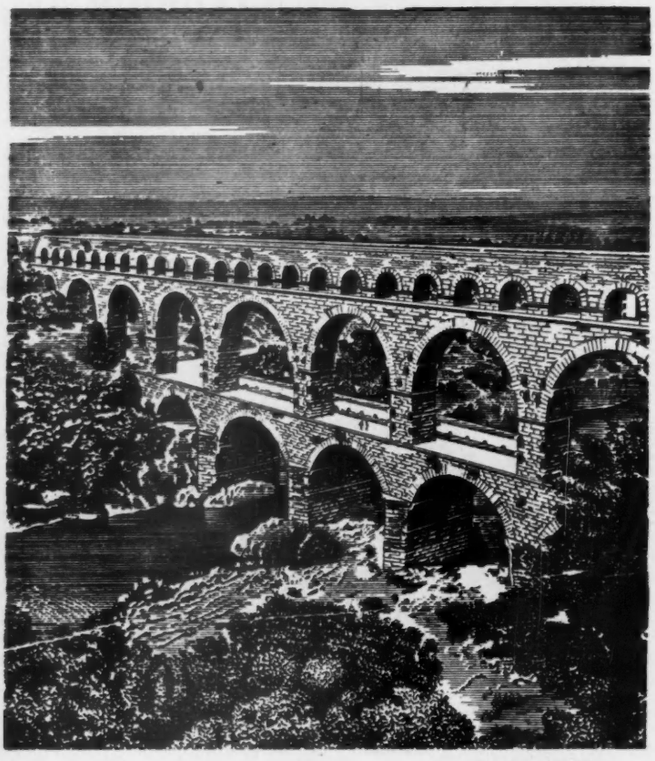

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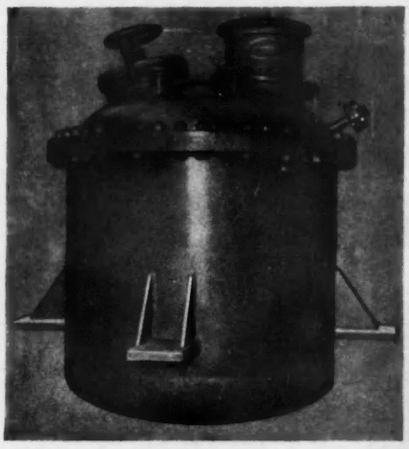

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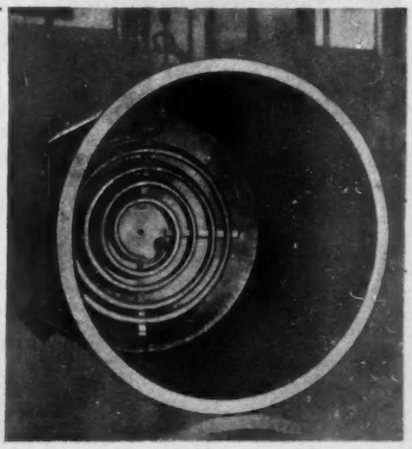

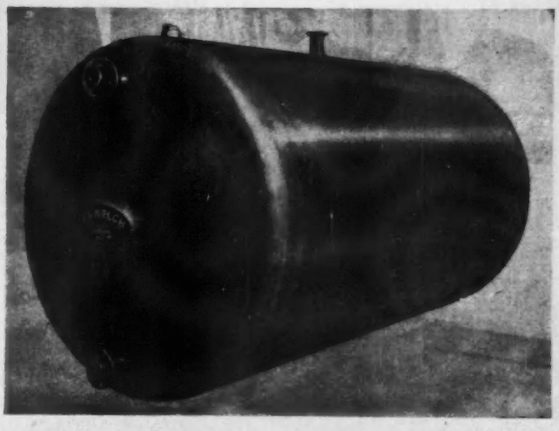

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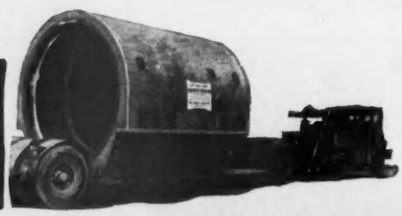

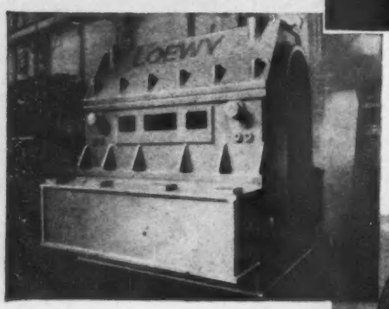

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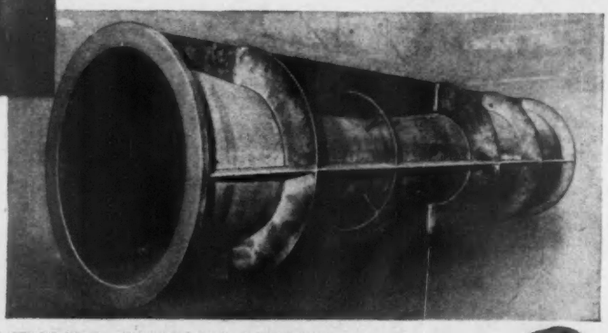

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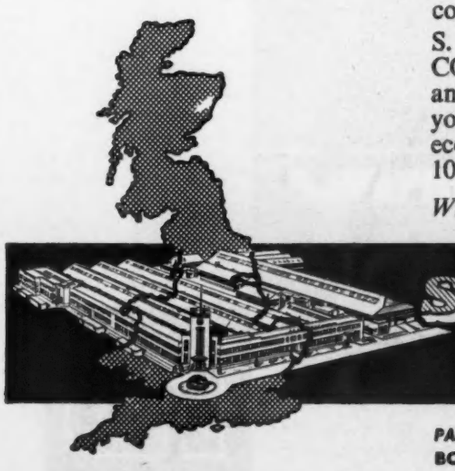

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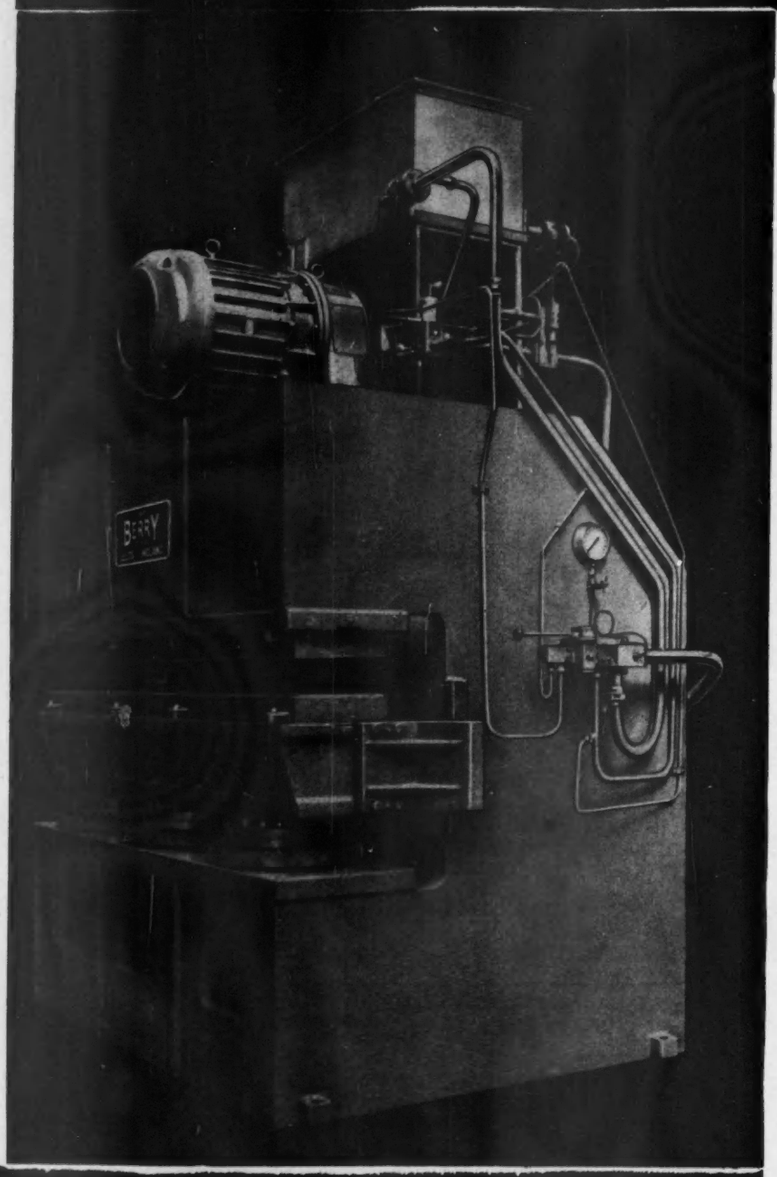

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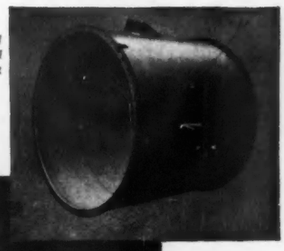
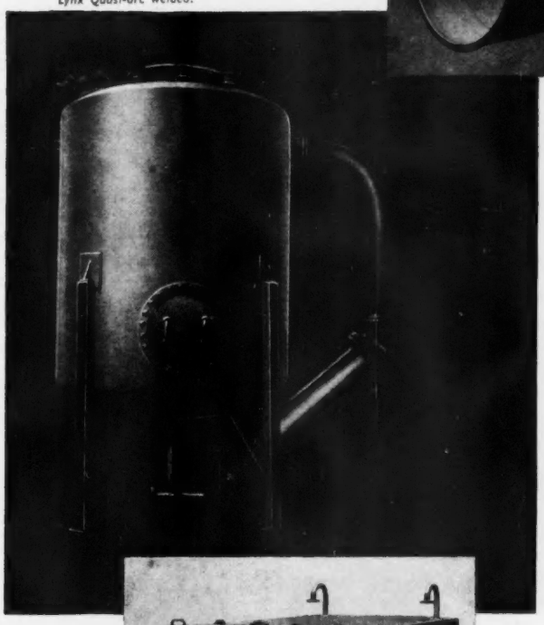
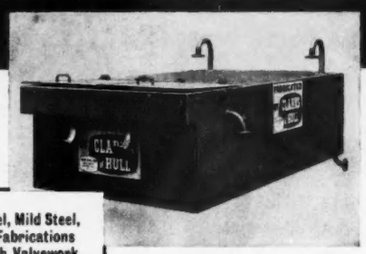


Stainless steel vessel with mild steel jacket

1,000 gall. kettle in ½" copper. Lynx Quasi-arc welded.





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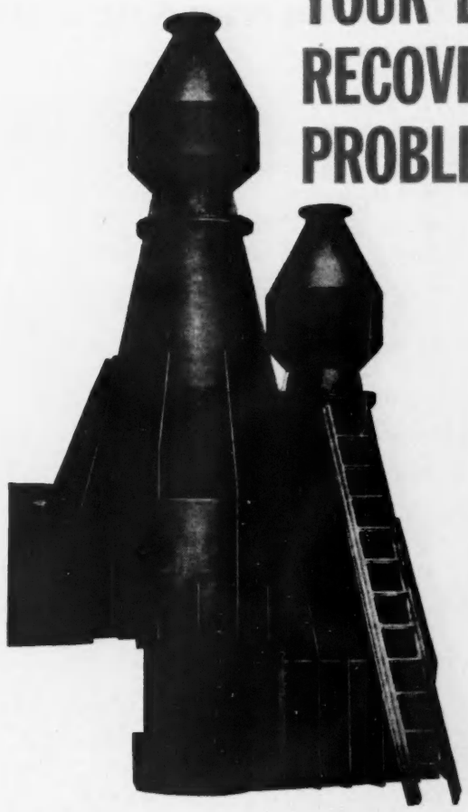

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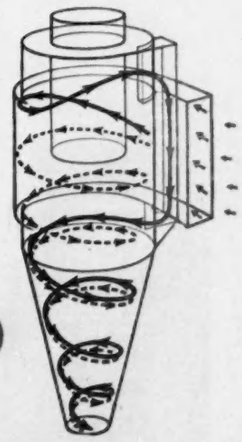

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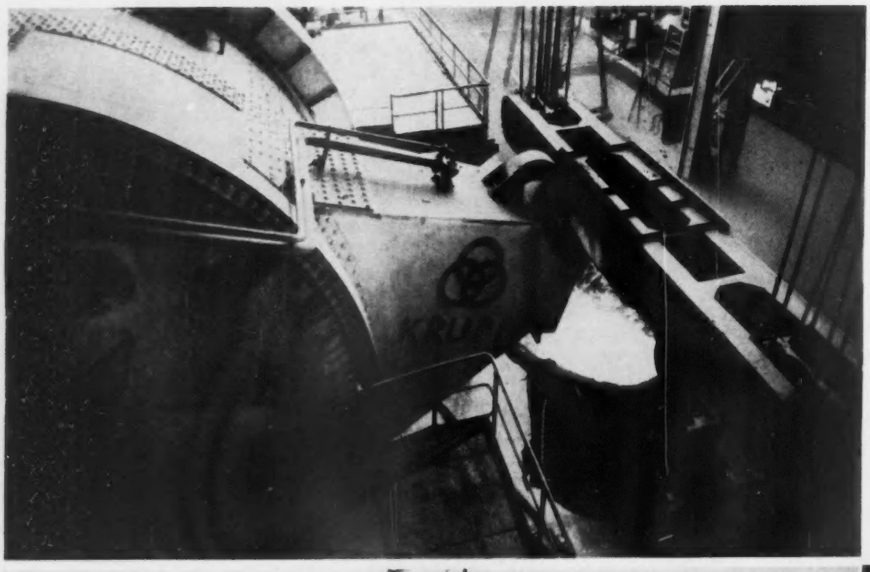

1

2

3

1
1700-ton **Hot Metal Mixer**
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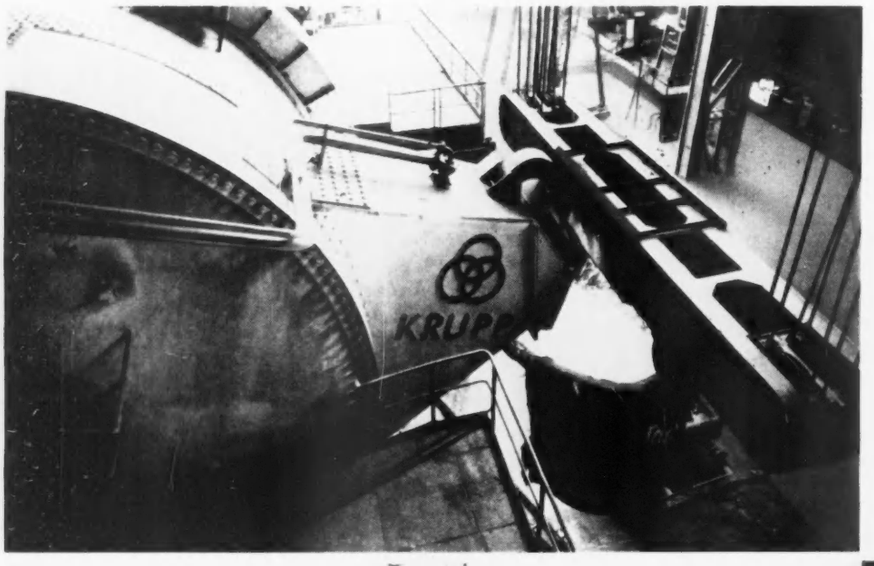

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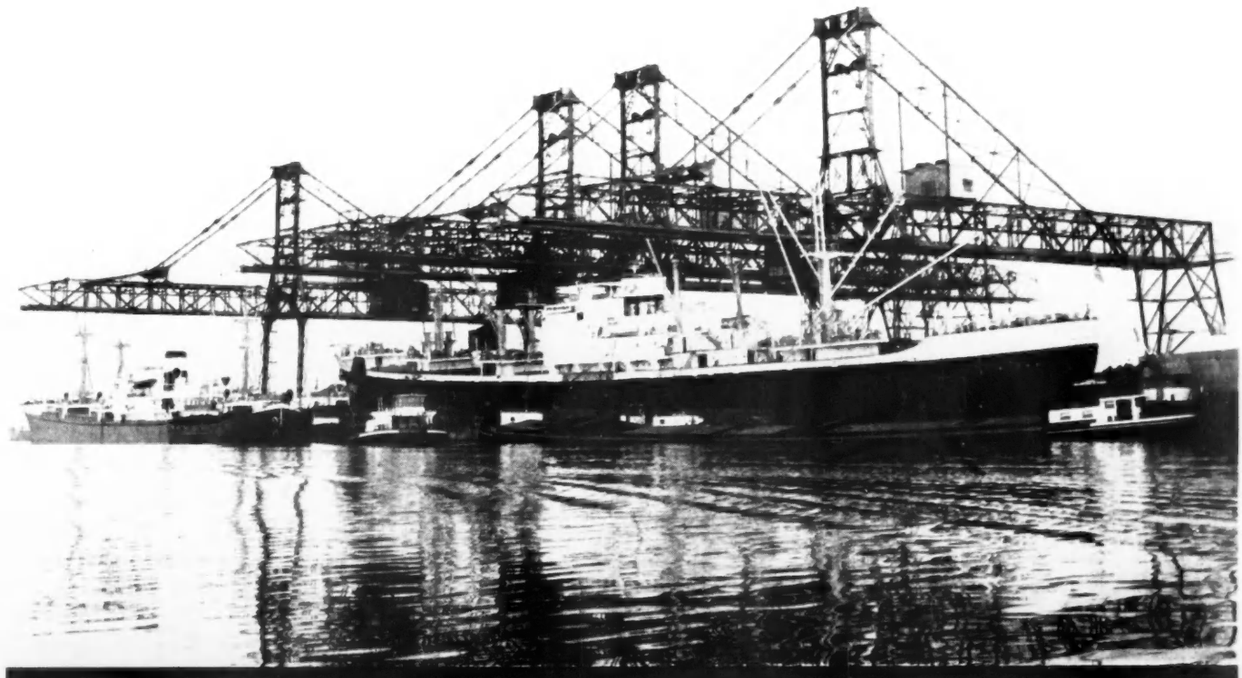

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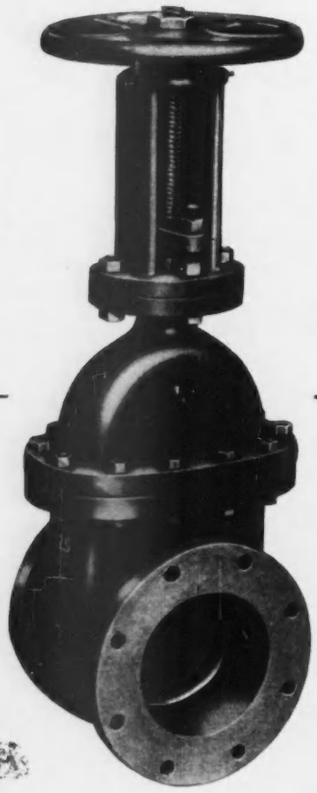

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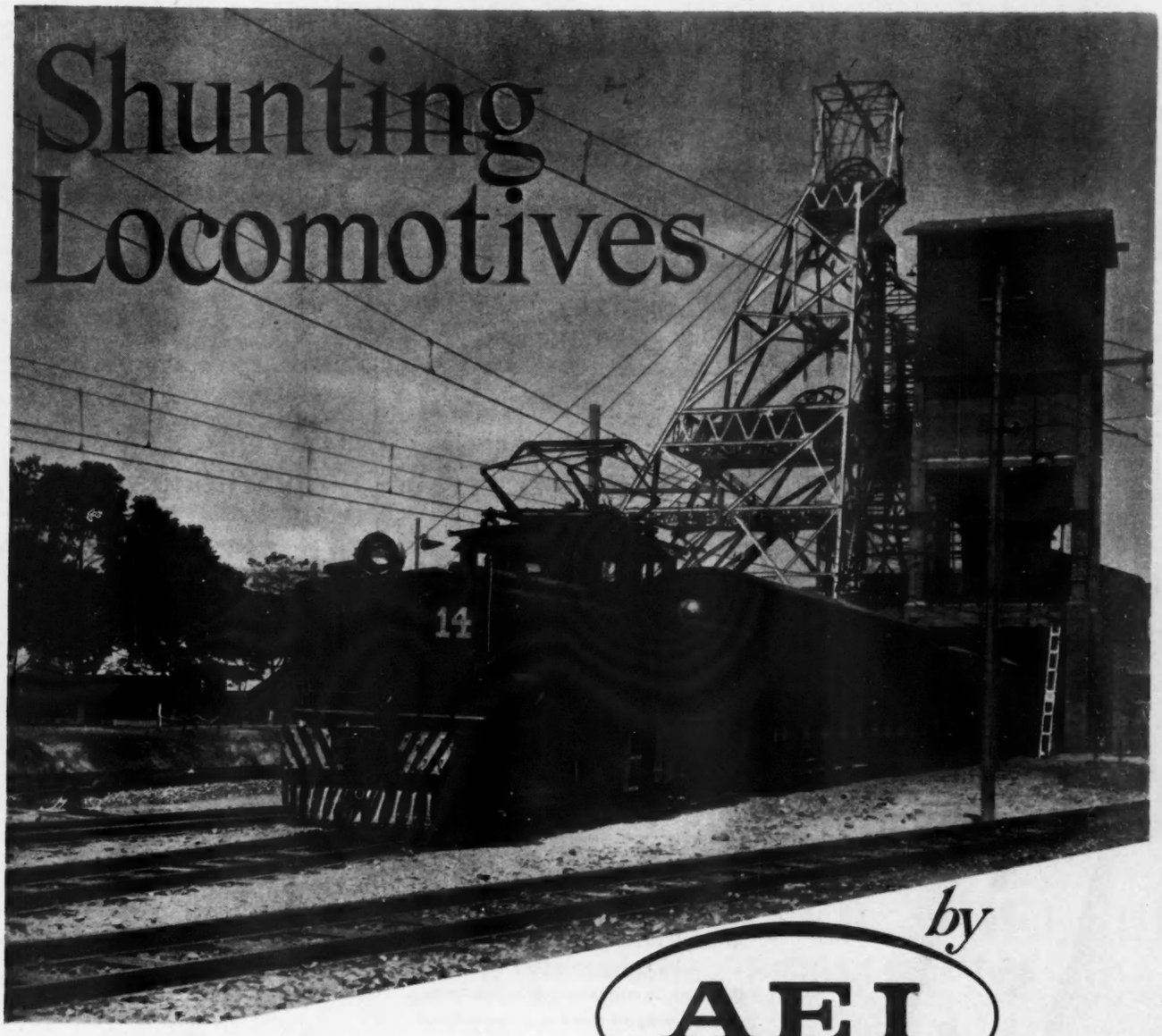

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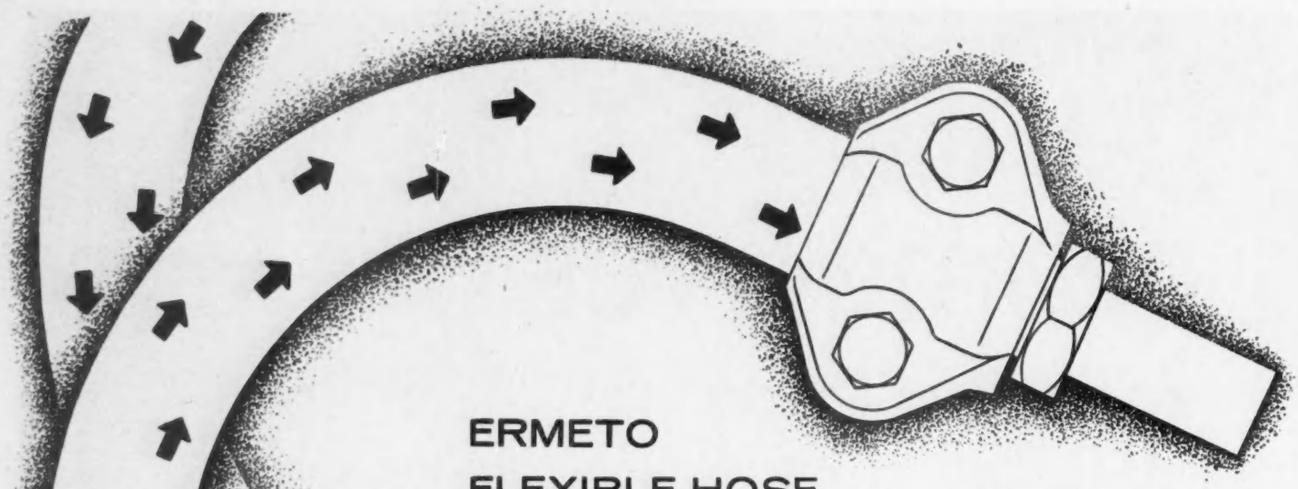

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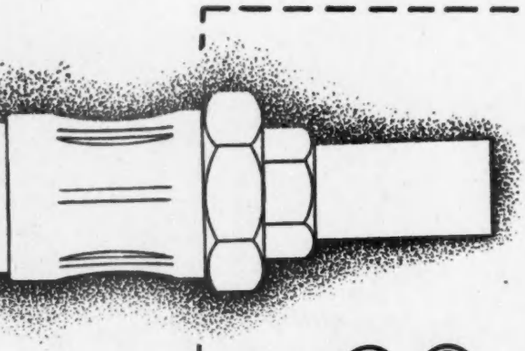
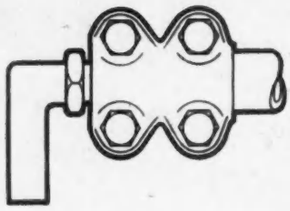
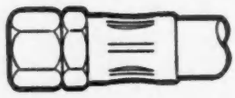
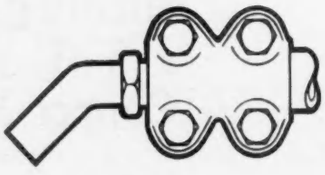
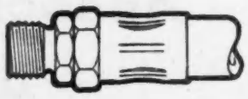
now with two ranges of end fittings











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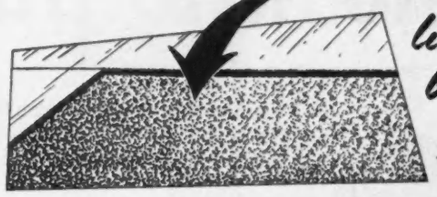

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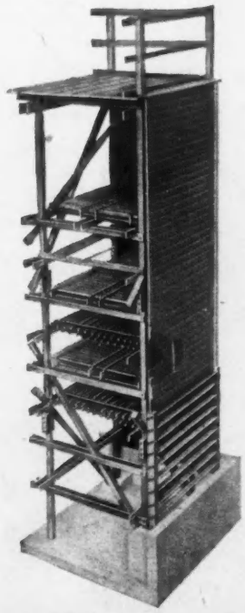

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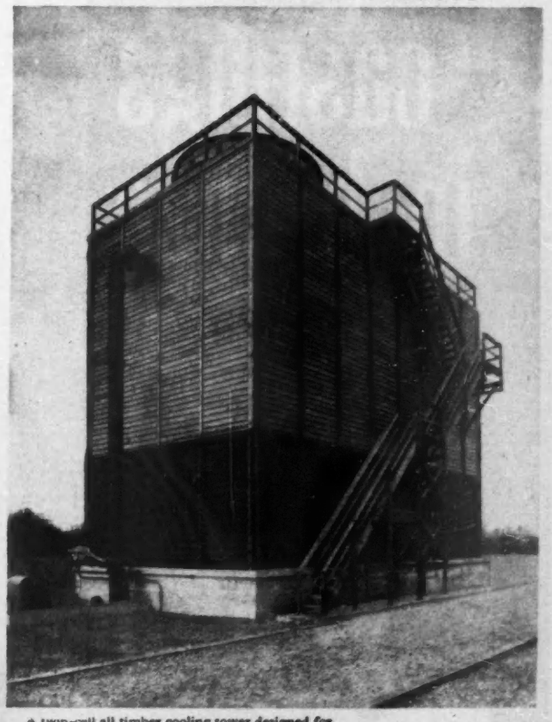

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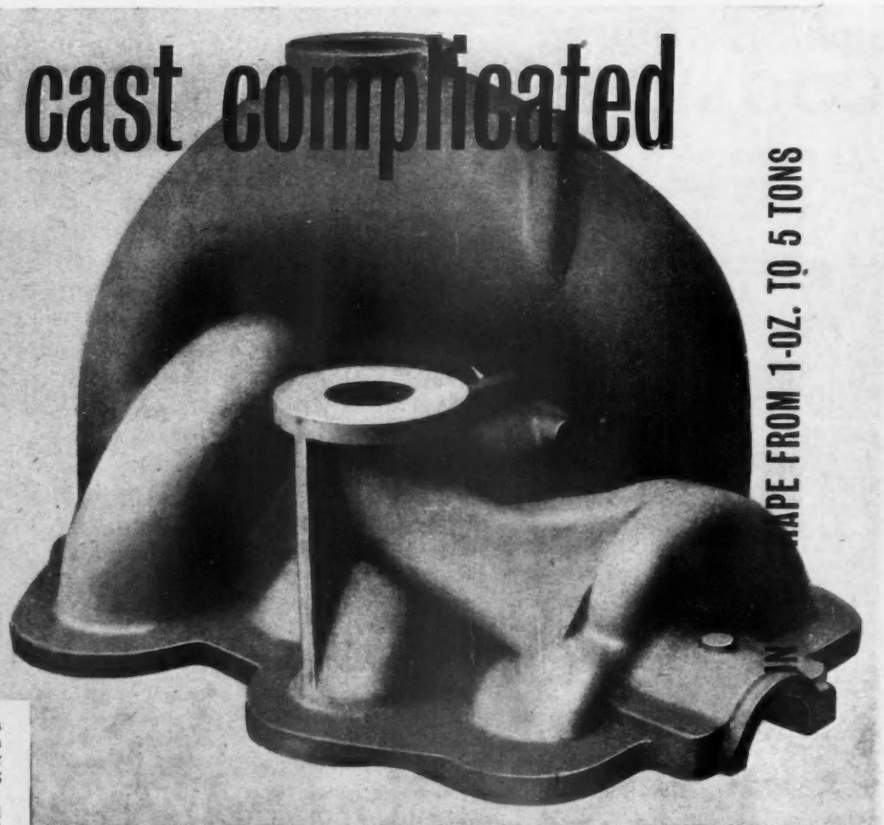

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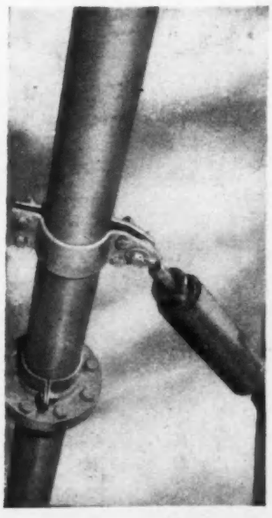

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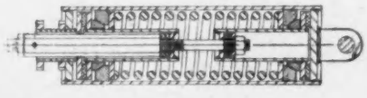
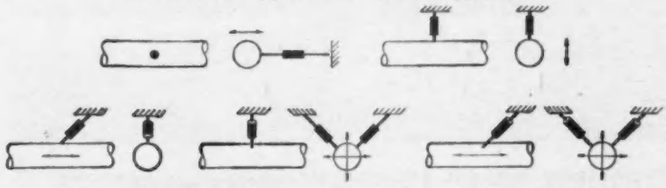


Vokes Genspring Non-Resonant Sway Braces

Sketches of suggested methods of application



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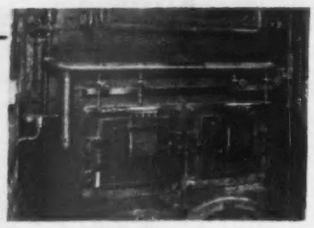

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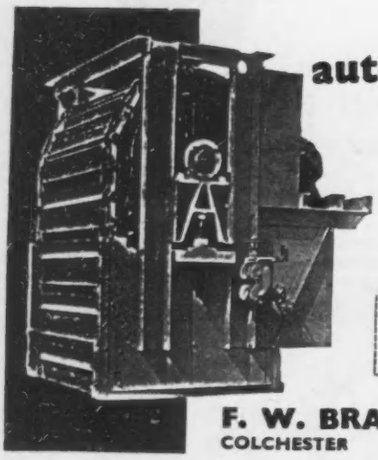

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ISIS Drafting Machines are now fitted with improved Protractor heads, the special features are fully explained in our ISIS catalogue, which will be gladly sent on request. The ISIS Drawing Tables are in complete balance at any height or inclination of the board.

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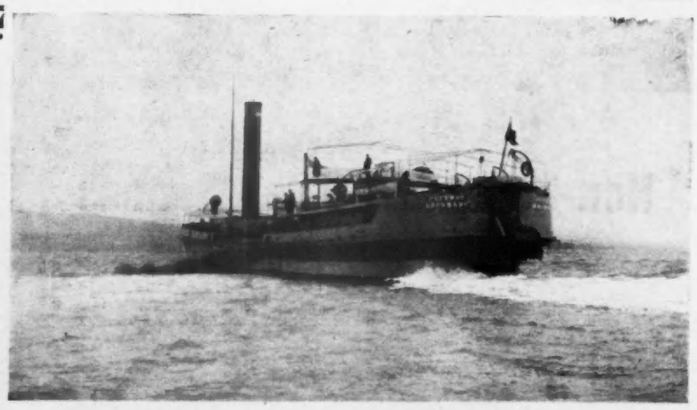

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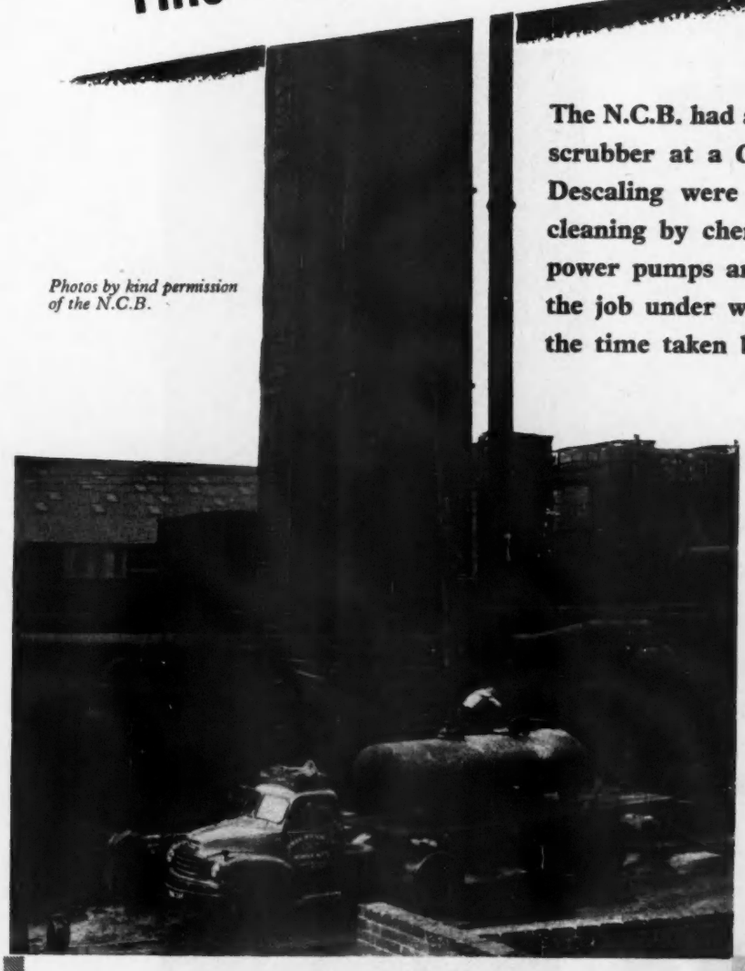

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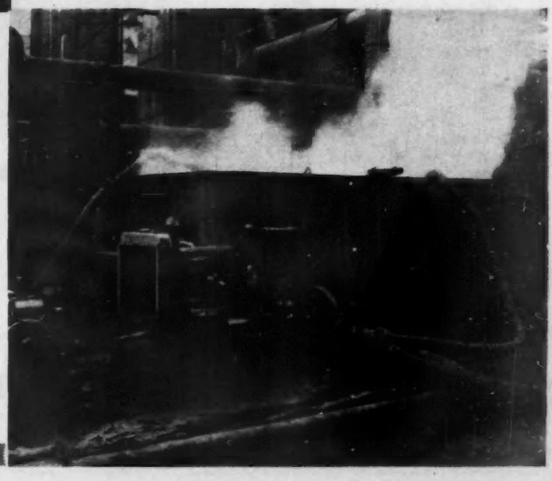

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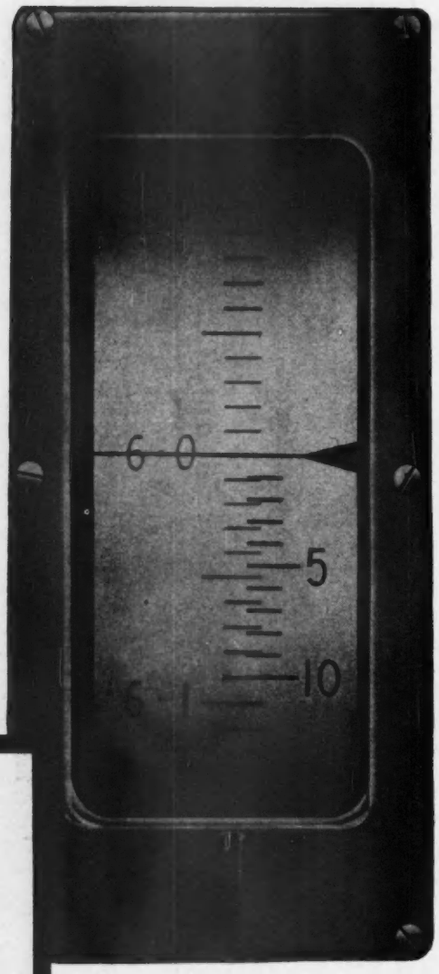

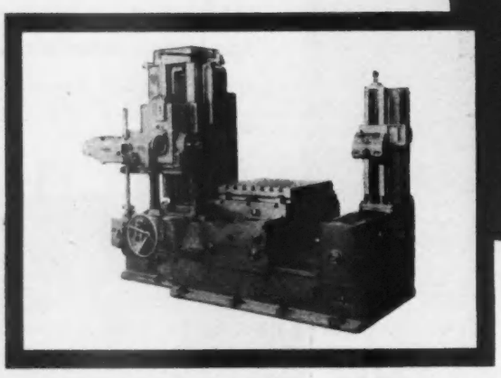

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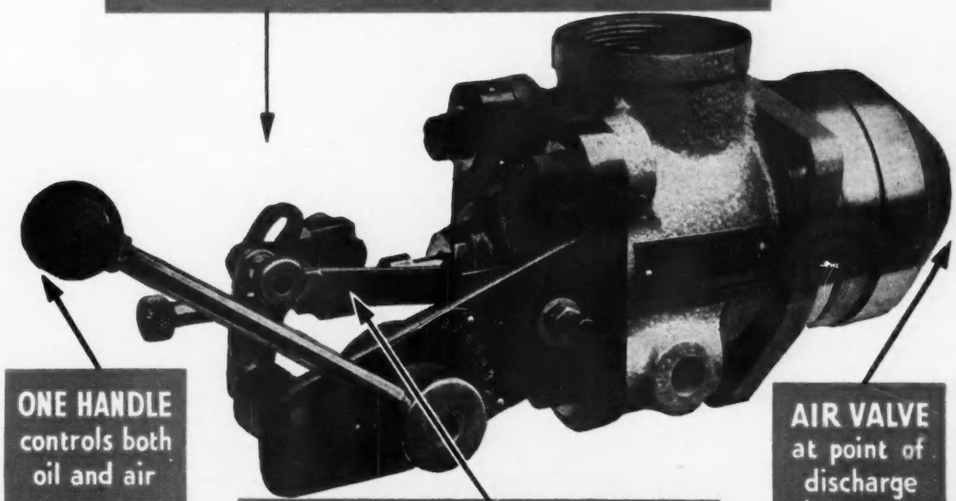

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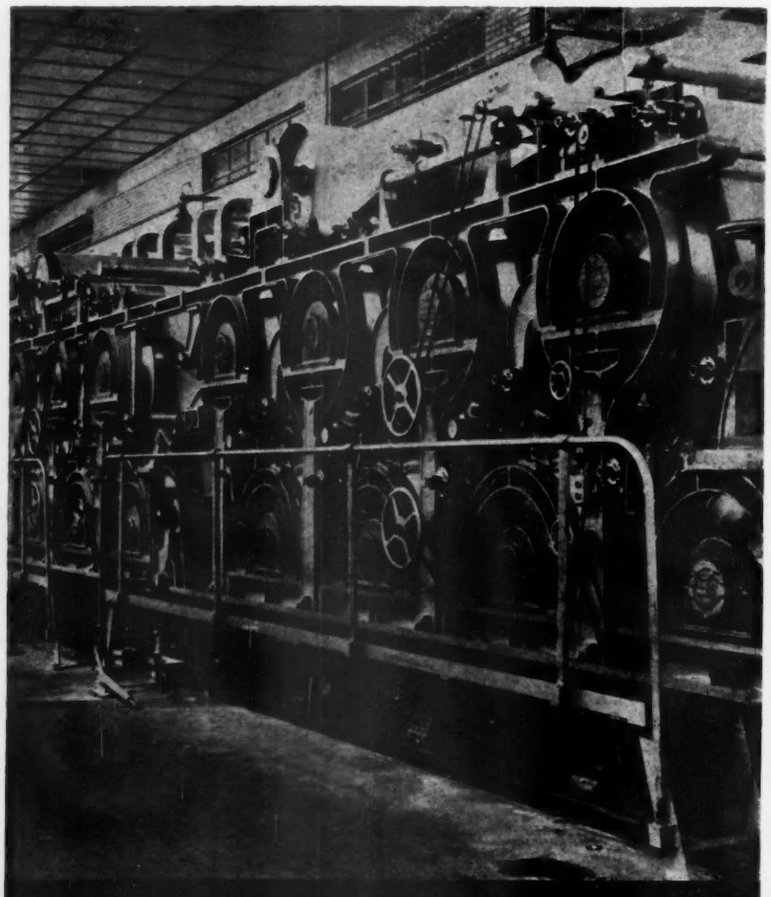

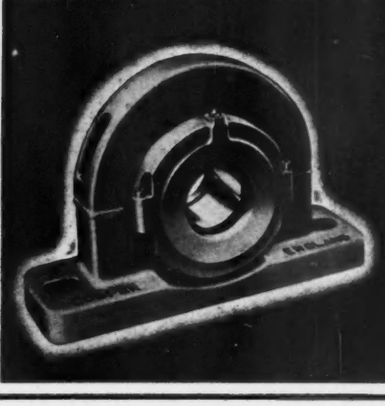

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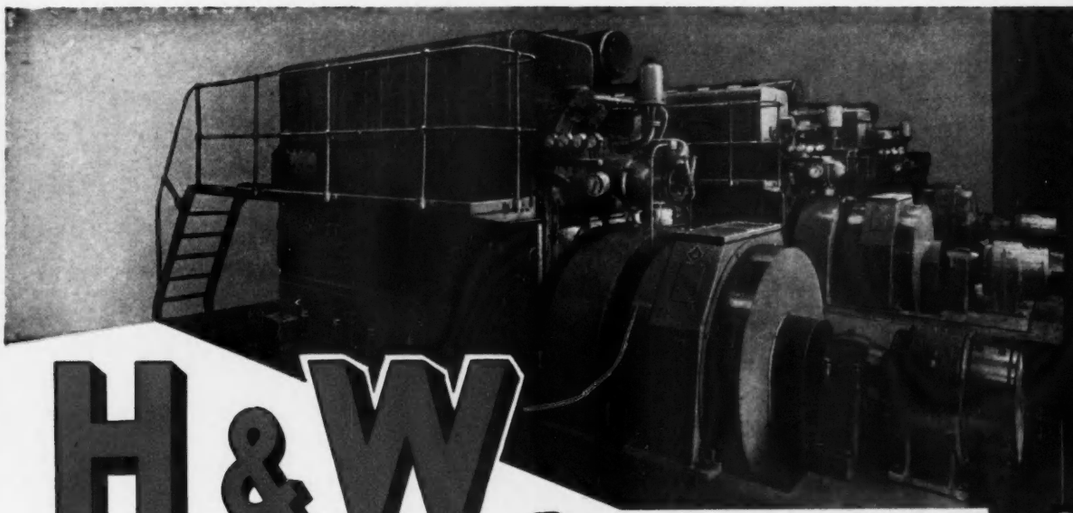

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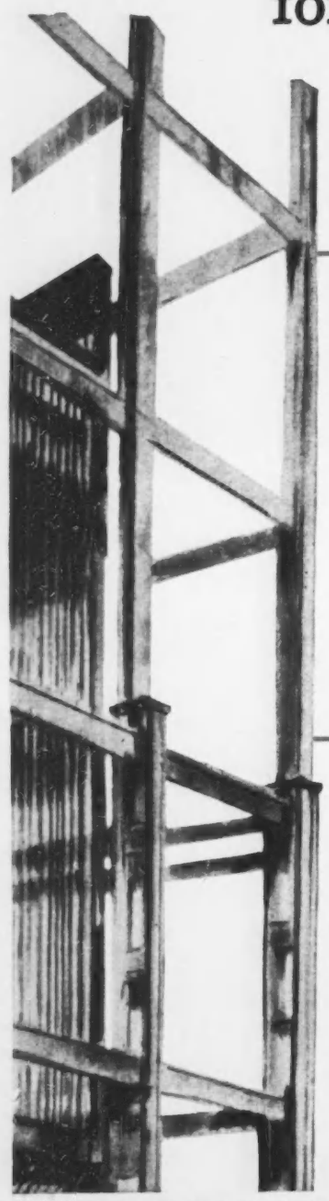
The International Combustion Organisation secures the contract for the LARGEST STEAM GENERATING UNITS for the Southern Hemisphere



International Combustion were responsible for the installation of the first 100 MW boiler units in the Southern Hemisphere—two units at TALLAWARRA, Australia.

◀ 100MW

Now at VALES POINT, Australia, two IC boilers of 200 MW capacity are to be installed :—

Continuous maximum rating : 1,350,000 lb/hr
Steam Pressure : 2,450 lb/sq. in.
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◀ 200MW

These will be the first high capacity controlled and assisted circulation boiler units in Australia and the first units in the country to employ a reheat cycle.

In England, International Combustion Limited are building five 200 MW units and one 550 MW unit for the Central Electricity Generating Board.

◀ 550MW

These projects indicate the confidence placed in IC equipment installed throughout the world, meeting the requirements both of large central electricity generation and the specialised applications of industry.

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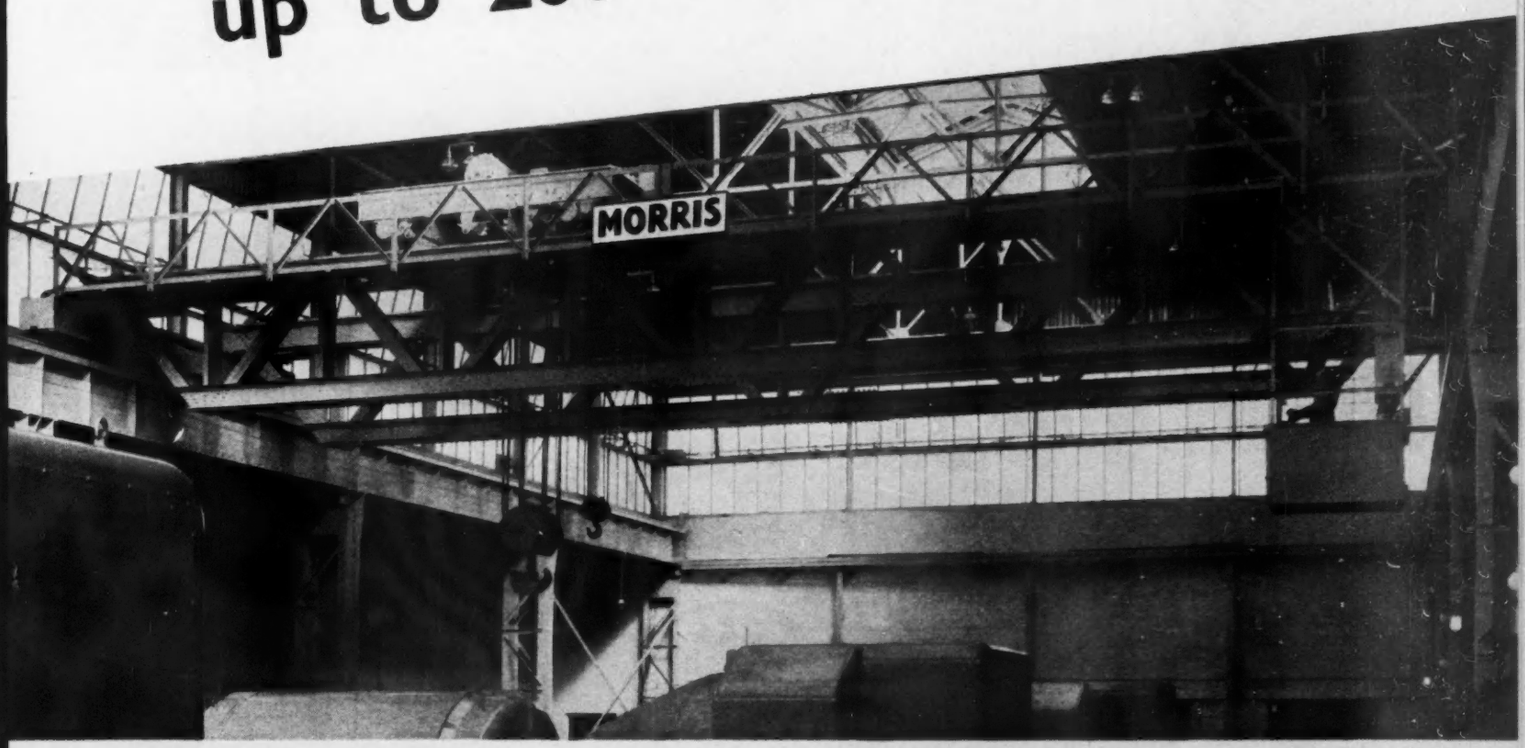

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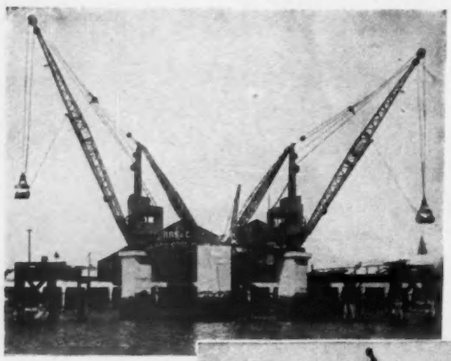

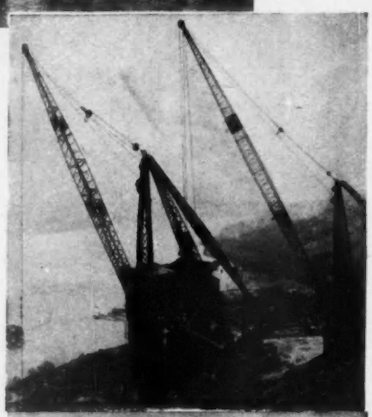

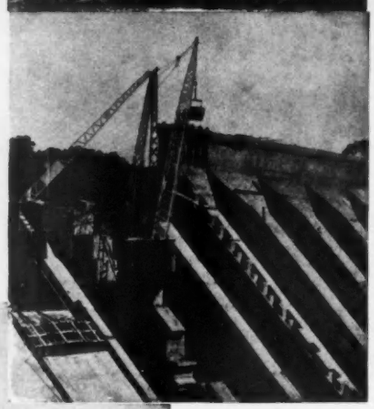

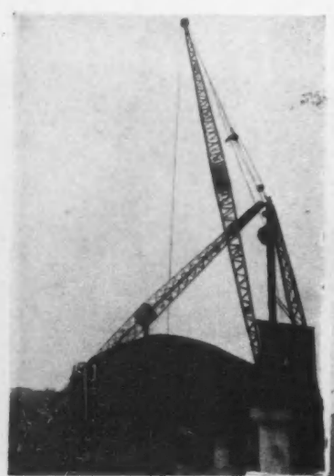

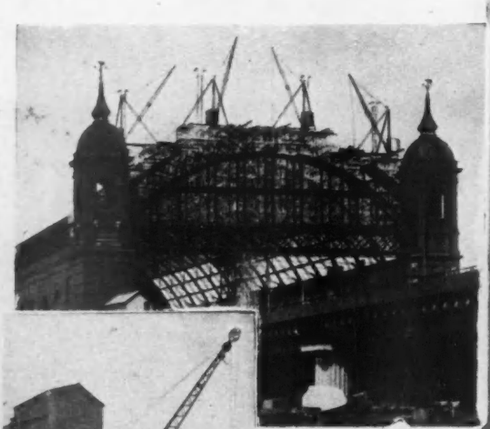

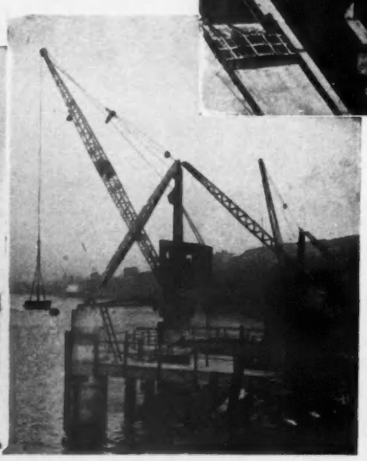

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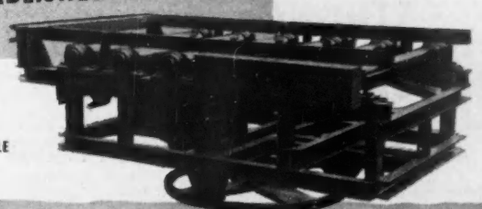

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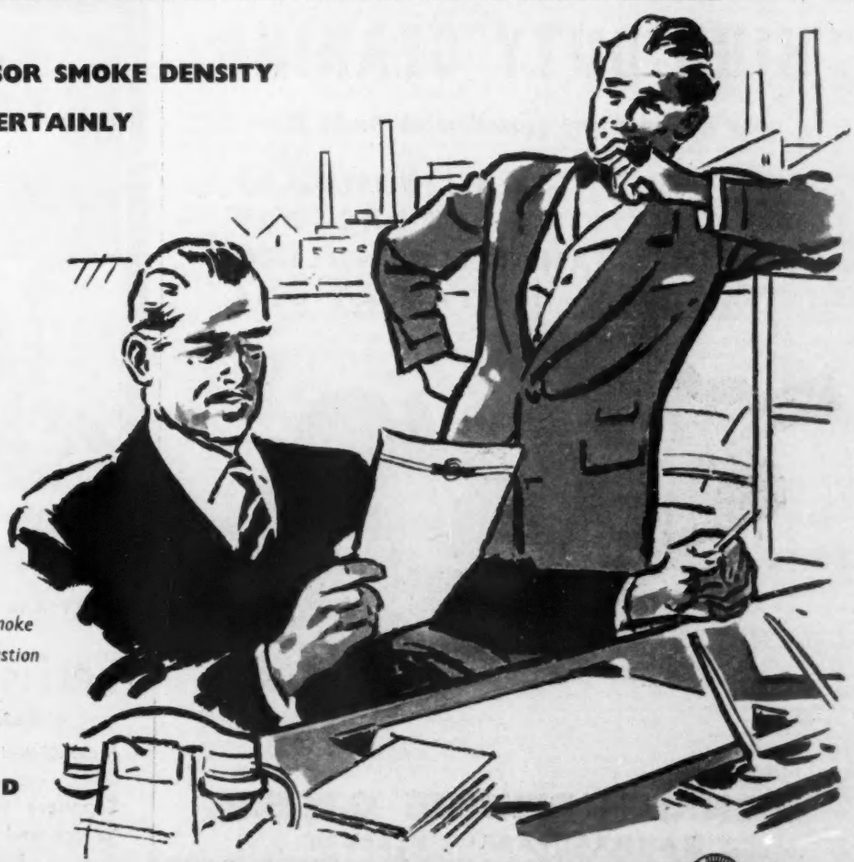

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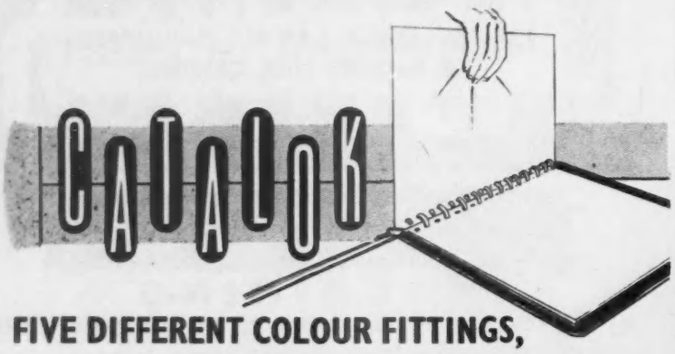

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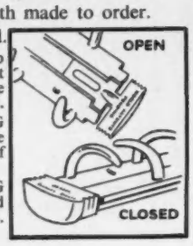

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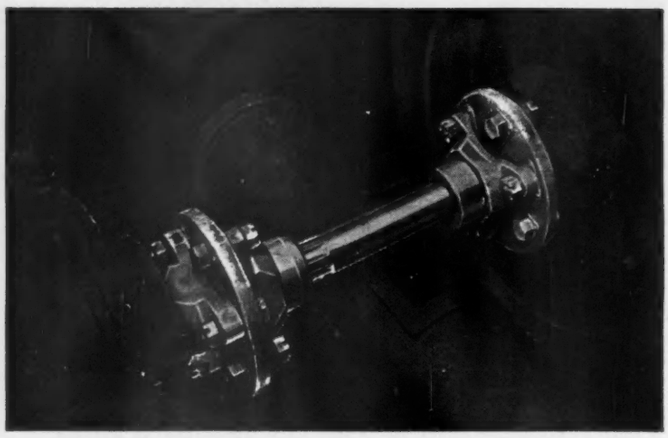

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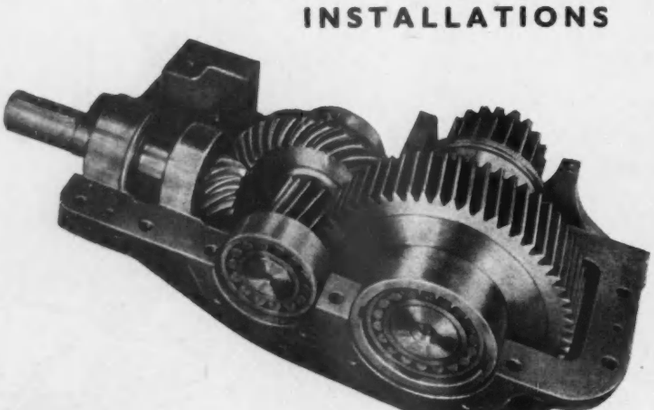

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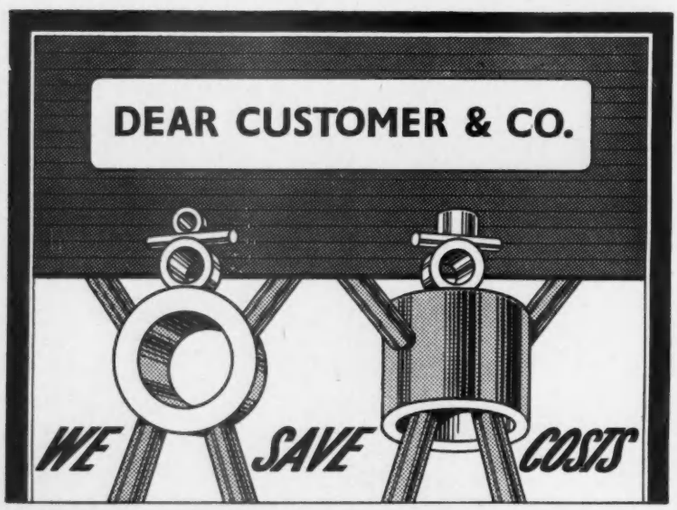

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There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £29 10s. ½-page £54. Full page £100.

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Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/- **Inch Rate.** 48/- per single column inch and pro rata. 12 lines to 1 inch.
There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an Illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. Tuesday for publication on Friday of the same week. If proofs are wanted, copy is required on Thursday for publication on Friday of the following week.

Advertisements for publication should be addressed to :—**Classified Advertisement Dept., "THE ENGINEER," 28 Essex Street, Strand, London, W.C.2**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

COURT LEES SCHOOL, BYERS LANE, SOUTH GODSTONE, SURREY

ENGINEERING INSTRUCTOR

An ENGINEERING INSTRUCTOR is required at this Home Office Approved School for 130 (shortly increasing to 160) boys aged from 13 to 16 years. The man appointed will be expected to initiate a new vocational training department giving instruction over a wide field in mechanical engineering. Qualifications equivalent to the full Technological Certificate of the City and Guilds of London are looked for, but a candidate with lesser qualifications would be considered. Experience in industry and in teaching would be of advantage. Salary for a fully qualified man Burnham Scale A (£520 to £1000 per annum), plus £120 per annum, entry to the scale depending on service. For a substantially qualified Instructor the scale is from £550 to £775 per annum. The Instructor would be expected to carry out duties outside normal working hours, for which an additional payment of £216 will be made. An unfurnished house, at present in course of construction, will be available at a rental of not more than £84 a year.

Application forms and further information may be had from the Headmaster. Please send an addressed envelope. E8523

UNIVERSITY OF SYDNEY

PETER NICOL RUSSELL CHAIR OF MECHANICAL ENGINEERING

Applications are invited for the PETER NICOL RUSSELL CHAIR OF MECHANICAL ENGINEERING. This Chair has become vacant owing to the death of Professor G. G. McDonald.

Salary will be at the rate of £A3750 per annum, plus cost-of-living adjustment. There is a retirement provision under the Professorial Superannuation Scheme.

Under the Staff Members' Housing Scheme, in cases approved by the University and its Bankers, married men may be assisted by loans to purchase a house. The Senate reserves the right to fill the Chair by invitation.

A statement of conditions of appointment and information for candidates may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1.

Applications close in Australia and London on 15th March, 1960. E8483

UNIVERSITY OF GLASGOW

I.C.I. RESEARCH FELLOWSHIPS

Applications are invited for I.C.I. RESEARCH FELLOWSHIPS in BIOCHEMISTRY, CHEMISTRY, ENGINEERING, PHARMACOLOGY, or PHYSICS, to which some appointments may be made during the current academic year. The appointments will date from 1st October, 1960. The Fellows will hold the status of Lecturers in the University. The salary will depend upon qualifications and experience, but will be within the range £700 to £1000 per annum, together with F.S.S.U. benefits and family allowances.

Applications (8 copies), with a list of publications and names of two referees, should be sent, not later than 29th February, 1960, to the undersigned, from whom further particulars may be obtained.

ROBT. T. HUTCHESON,
E8485 Secretary of University Court.

MINISTRY OF TRANSPORT

CIVIL ENGINEERS

Pensionable posts for men and women at least 25 and under 35 on 1st January, 1960 (extension for regular Forces service, Overseas Civil Service, established civil service, and temporary Government service as Civil Engineer). Candidates must have achieved Corporate Membership of Institution of Civil Engineers or passed examinations necessary for attaining such membership. Experience in road and bridge construction essential ; knowledge of Highways Authorities' procedure desirable. Starting salary (men, London) from £830 to £1125 according to age. Scale maximum (London) £1300. Promotion prospects.—Write Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting S64/7. E8510

PUBLIC APPOINTMENTS

LEICESTER ROYAL INFIRMARY

ASSISTANT ENGINEER

Applications are invited for the post of ASSISTANT ENGINEER. Salary, at present under review, on the scale £575–£700. The successful applicant will be directly responsible to the Superintendent Engineer and may either be required to take direct charge of the maintenance and operation of the engineering plants of several small hospitals or to assist the Senior Engineers at the larger hospitals in the Group. He will be required with other engineers, to take part in an "On Call" rota. Applicants must have completed an apprenticeship in, or have a sound practical knowledge of mechanical engineering. Preference will be given to applicants with the O.N.C. in Mechanical Engineering, which includes heat and heat engines. There is no accommodation available. Applications stating age, qualifications and experience, together with names of three referees (who should be present, and/or past employers) to the Group Secretary, The Leicester Royal Infirmary within fourteen days of the advertisement. E8508

BRITISH SHIPBUILDING RESEARCH ASSOCIATION

The British Shipbuilding Research Association has a vacancy in its Naval Architecture for a person with ability to initiate, lead and execute research. For this post the applicant should have an honours degree in naval architecture. The ceiling of salary is £1600 per annum and the commencing salary will depend upon age and qualifications. There are opportunities of promotion above this ceiling to a higher grade.

In addition to the investigations which the research staff themselves conduct, including work on board ships, they are also engaged upon progressing a programme of researches carried out under contract at outside laboratories, Government research establishments, Universities, &c. Members of the staff also deal with the technical secretarial work of the Association's system of research committees. All positions carry superannuation.

Applications, with full particulars of education, apprenticeship, practical training and research experience, should be addressed to B.S.R.A., 5, Chesterfield Gardens, Curzon Street, London, W.1. E8541

CHESTERFIELD, BOLSOVER AND CLOWNE WATER BOARD

ENGINEERING ASSISTANT

Applications for the above appointment are invited from Graduate Members of the Institution of Civil Engineers or from University Graduates who have had five years' engineering experience—preferably in waterworks practice.

The salary offered will be within the Special Grade, £785–£1070 per annum. The successful applicant will be granted a motor-car allowance. The post is a superannuated one and a medical examination will be necessary.

Applications, together with the names of two persons to whom reference can be made, should be forwarded to the Board's Engineer and Manager, at New Beetwell Street, Chesterfield, not later than January 30th next.

RICHARD CLEGG,
E8527 Clerk to the Board.

HERTFORDSHIRE COUNTY COUNCIL

TECHNICAL INFORMATION SERVICE

INDUSTRIAL LIAISON OFFICER

Applications are invited from Graduates or other suitably qualified individuals with industrial experience, preferably in management or information work, for a new appointment as INDUSTRIAL LIAISON OFFICER.

The post calls for an aptitude in discussing technical problems and the initiative to encourage firms to utilise local and national sources of information.

Salary : £1370 per annum by £35 to £1550 per annum, plus travel allowances.

Further details from the County Education Officer, County Hall, Hertford, to whom completed applications should be returned by February 12th, 1960. E8481

PUBLIC APPOINTMENTS

BANSTEAD HOSPITAL MANAGEMENT COMMITTEE

SUPERINTENDENT ENGINEER

Applications are invited for the post of SUPERINTENDENT ENGINEER. The person appointed will be directly in charge of the engineering services of the Hospitals in the Group, with a total of 2416 beds, and will be responsible for their efficient operation. Candidates must possess one or more of the following qualifications, or equivalent, approved by the Ministry of Health :

(a) Ministry of Transport and Civil Aviation (ex Board of Trade) 1st Class Certificate of Competency in Marine Engineering, or 1st Class Certificate of Service as 1st Class Engineer.

(b) City and Guilds of London FULL Technological Certificate in Plant Engineering (1st Class).

Practical experience in Hospital engineering is desirable. Salary scale (40)-50 points)—£1020–£1180, plus £50 London weighting per annum. A house will be available at an annual rental of £46 11s. 6d., plus rates. Whitley Council Conditions of Service apply.

Applications, stating age, qualifications, experience and the names of three referees, should be forwarded to the Group Secretary, Banstead Hospital, Sutton, Surrey, within 10 days of appearance of this advertisement. E8546

BRITISH STANDARDS INSTITUTION

TECHNICAL STAFF

The B.S.I. invites applications from MECHANICAL ENGINEERS to join the technical staff of the Institution. This staff is responsible for the work of the Institution in the preparation of British Standards in co-operation with the various sections of industry and is required to plan and progress the work. They act as secretaries to technical committees.

Applicants should have a university degree or equivalent professional qualification in mechanical engineering, and preferably some experience in engineering metallurgy.

There are three grades of appointment with an overall salary range up to £2000 plus ; applications are invited for the basic grade, the starting salary being dependent on individual qualifications and experience. The posts are pensionable.

Apply to the Establishment Officer, B.S.I., 2, Park Street, London, W.1. E8549

BRITISH TRANSPORT DOCKS

APPOINTMENTS

British Transport Docks invite applications for the positions of : (1) SENIOR ENGINEERING ASSISTANT (CIVIL) at South Wales Docks (office at Barry, Glamorgan), and (2) ENGINEERING ASSISTANT (CIVIL) at Goole, Yorkshire.

Candidates should have experience in the design, specification, construction and execution of general civil engineering works, preferably with knowledge of dock and harbour installations. Professional qualifications desirable. Salary range : post (1), £1095–£1265 per annum ; post (2), £1045–£1150 per annum. Contributory superannuation scheme and certain rail travel facilities.

Applications, giving age, education, training, experience and qualifications, to : Staff and Establishment Officer, British Transport Docks (TE), 163, Euston Road, London, N.W.1, to arrive not later than Monday, 25th January, 1960. E8499

GOVERNMENT OF KENYA

MINISTRY OF WORKS

ENGINEER (ELECTRICAL)

To design electrical installations in public institutions, airports and housing.

Contract appointment with prospects of permanency. Salary range £1194–£1863. Gratuity. Free passages. Quarters when available at low rent.

Candidates, 26–45 years, must be A.M.I.E.E., or possess a University Degree in Electrical Engineering and have relevant experience.

Write, Director of Recruitment, Colonial Office, London, S.W.1, giving full names, age, qualifications and experience, quoting BCD 112/7/027/D4. E8477

PUBLIC APPOINTMENTS

NEW ZEALAND MINISTRY OF WORKS

ENGINEERING STAFF

The New Zealand Ministry of Works invites applications for the following vacancies on the Permanent Staff. Positions, qualifications desired, and salaries offered, are as follows :

Vacancy No. 1.—CIVIL ENGINEERS
Corporate Membership of the Institution of Civil Engineers, London, together with sufficient appropriate experience. Commencing salaries up to £1525 per annum.

Vacancy No. 2.—ASSISTANT CIVIL ENGINEERS
A University Degree in Civil Engineering, or Graduate Membership of the Institution of Civil Engineers, London, with at least five years of practical experience since commencement of pupilage. Commencing salaries : £870 up to £1060 per annum.

Vacancy No. 3.—MECHANICAL or ELECTRICAL ENGINEERS.
Corporate Membership of the Institutions of Mechanical or Electrical Engineers, London, together with sufficient appropriate experience. Commencing salaries up to £1525 per annum.

Vacancy No. 4.—BUILDING SERVICES ENGINEERS
Corporate Membership of the Institution of Heating and Ventilating Engineers, London. Commencing salaries up to £1450 per annum.

Vacancy No. 5.—ASSISTANT MECHANICAL or ELECTRICAL ENGINEERS
A University Degree in Mechanical Engineering or Graduate Membership of the Institutions of Mechanical or Electrical Engineers, London, together with at least five years' experience since commencement of pupilage. Commencing salaries : £870 up to £1060 per annum.

Vacancy No. 6.—ASSISTANT BUILDING SERVICES ENGINEERS
Graduate Membership of the Institution of Heating and Ventilating Engineers, London, with at least five years' experience since commencement of pupilage. Commencing salaries : £870 to £1060 per annum.

Civil Engineers and Assistant Engineers must have had experience in the design or construction of multi-storied reinforced concrete buildings or bridges and other structures. For the other vacancies experience is necessary in the design and installation of services or equipment for one or more of the following : heating and ventilating, air conditioning, hot and cold water or sewerage services, laundries, kitchens, boiler-houses, lifts and other mechanical services in offices, schools, hospitals, hotels, telephone exchanges, printing works, defence establishments, &c. All appointees will be required to undertake work of this nature.

APPLICANTS MUST BE RESIDENT IN THE UNITED KINGDOM OR EIRE AND HAVE FULFILLED NATIONAL SERVICE OBLIGATIONS.

Enquiries, mentioning this publication and stating the Vacancy Number and the position sought, should be addressed to the High Commissioner for New Zealand, 415, Strand, London, W.C.2. Full details of duties, experience required, general information on the conditions of employment in the New Zealand Public Service, and application forms, will then be supplied. E8411

MINISTRY OF AVIATION

ASSISTANT TECHNICAL COST OFFICERS

Ministry of Aviation requires ASSISTANT TECHNICAL COST OFFICERS for unestablished posts in London and Mottingham, to prepare estimates of prime costs of manufacture of engineering productions. The duties normally involve a considerable amount of travelling.

Qualifications : Recognised engineering apprenticeship or equivalent training in an appropriate trade. Good practical experience in ratefixing, operational planning and prime cost estimating of engineering productions. Vacancies exist in Sections concerned with general mechanical and electrical productions, aircraft, instruments and the manufacture of electronic equipments. Good machine shop experience would also be an advantage. Possession of an O.N.C., C. and G. Final Certificates, or equivalent qualification is desirable.

Salary : £900 (age 30) to £1065 per annum.

Application forms from Manager (P.E.16), Ministry of Labour, Professional and Executive Register, Atlantic House, Farringdon Street, London, E.C.4. E8516

Classified Advts. continued on page 110

PUBLIC APPOINTMENTS

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

PRINCIPAL SCIENTIFIC OFFICER

Pensionable post for man or woman to serve initially for about 3 years at the Shirley Institute of the British Cotton Industry Research Association, Manchester, for work on development of automatic spinning plant for the conversion of natural and synthetic fibres into yarn; and subsequently at the National Engineering Laboratory, East Kilbride, for research in the field of mechanical engineering. Housing will be available at East Kilbride for married staff. Qualifications: Normally 1st or 2nd class honours degree in mechanical engineering or high professional attainment. Experience of the application of automatic control systems and mechanical handling and transfer equipment essential, and a broad engineering background desirable. Knowledge of the textile industry is not essential. Men's salary scale £1460–£2070. Starting pay may be above minimum. Promotion prospects. Write Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting S5088/60. Closing date 11th February, 1960. E8540

SOUTH EASTERN GAS BOARD

ISLE OF GRAIN WORKS

ELECTRICAL ENGINEER

Applications are invited for the appointment of ELECTRICAL ENGINEER at the Isle of Grain Works of the Board.

The electrical installation will comprise a power house having a capacity of 9500kW, operating in parallel with the public supply system, with associated high and low voltage distribution systems, a.c. and d.c. motors and control gear.

Applicants should preferably be Corporate Members of the Institution of Electrical Engineers, and must have extensive practical experience in the operation, control and maintenance of back pressure turbine and oil engine-driven alternators, high and low voltage switchgear, power cabling, mercury arc rectifiers, a.c. and d.c. motors, control gear and automatic control systems.

Salary within range £1235–£1533 per annum, according to qualifications and experience.

Applications, in writing, quoting reference V14/1155, and giving full details, to the Personnel Manager, South Eastern Gas Board, Katharine Street, Croydon, Surrey, within seven days. E8494

MINISTRY OF HOUSING AND LOCAL GOVERNMENT

ENGINEERING INSPECTORS

Four pensionable posts in London for men and women at least 35 on 1st January, 1960. Duties involve investigation of technical and economic merits of engineering proposals submitted to the Ministry. Qualifications: A.M.I.C.E., and wide experience of civil engineering work. Special knowledge and experience in one or more of the following fields essential: sewerage and sewage disposal, sea defence, water supply. Honours degree in Engineering an advantage. Starting salary (men, London) from £1600 at 35 to £1890 (or higher if exceptionally well qualified or experienced) at 40 or over. Scale maximum £2450 (London). Promotion prospects.—Write Civil Service Commission, 17, North Audley Street, London, W.1, for application form quoting S5085/60/10. Closing date 16th February, 1960. E8511

MINISTRY OF AVIATION

PYESTOCK, HANTS

TECHNICIAN

Ministry of Aviation requires a TECHNICIAN at Pyestock, Hants, for running of large electrically-driven compressor sets and other plant, and operation and maintenance of E.H.V. indoor and outdoor switchgear. Duties include supervision of electrical control room and sub-station, may involve some shift work. Qualifications: Recognised engineering apprenticeship in electrical industry, and not less than five years' experience of power station generators. Familiarity with Safety Regulations of Central Electricity Generating Board. H.N.C. or equivalent qualifications. Salary: £1005–£1220 p.a. Forms from Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting D 668/9A. Closing date, 30 January, 1960. E8512

WEY VALLEY WATER COMPANY

GENERAL MANAGER AND CHIEF ENGINEER

Applications are invited for the above appointment. The person appointed will be directly responsible to the Board of Directors for the management and engineering development of the undertaking.

Applicants must be experienced water engineers and have held responsible positions in a water undertaking. They should be Corporate Members of the Institution of Civil Engineers, and of the Institution of Water Engineers. The person appointed will be required to take up his duties not later than October, 1960. Salary £3500 a year and pension. Applications, giving full particulars of training, experience and positions held, and applicant's age, must be sent to the Chairman of the Wey Valley Water Company, c/o Messrs. Rofe & Raffety, 9, Brewer's Gardens, London, S.W.1, to arrive not later than 22nd March, 1960. E8456

PUBLIC APPOINTMENTS

ROYAL NAVAL SCIENTIFIC SERVICE

SENIOR SCIENTIFIC OFFICERS AND SCIENTIFIC OFFICERS

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS required in following localities: LONDON AREA: MECHANICAL ENGINEER with sound knowledge of basic principles of thermo and fluid dynamics, to carry out research programme in particular field of applied hydrodynamics. Experience in modern methods of design and research on axial flow compressors, turbines or pumps an advantage. MECHANICAL ENGINEER for research on precision gear design. MECHANICAL ENGINEER for work on propulsion problems. APPLIED MATHEMATICIAN for research of basic nature on stability of underwater vehicles; knowledge of theoretical hydrodynamics and theory of control mechanisms an advantage. APPLIED MATHEMATICIAN or THEORETICAL PHYSICIST for acoustic analysis. APPLIED MATHEMATICIAN for work with electronic computers, with special reference to research into general underwater physical problems. ELECTRONIC PHYSICISTS for data handling and analysis problems. EXPERIMENTAL PHYSICIST for research in underwater acoustics. PHYSICIST interested in operation performance. CLASSICAL PHYSICISTS.

BALDOCK: PHYSICISTS or APPLIED MATHEMATICIANS for research in Metal or Quantum Physics.

PORTSMOUTH: PHYSICISTS with experience in field of microwave techniques. ELECTRONIC/ELECTRO-MECHANICAL ENGINEERS (experience in servo-mechanisms an advantage).

HASLEMERE: ELECTRONIC ENGINEER.

PORTLAND: PHYSICISTS or APPLIED MATHEMATICIANS for research in underwater acoustics. PHYSICISTS (general). ELECTRICAL ENGINEERS with advanced electronic design experience. MECHANICAL ENGINEERS. PHYSICAL CHEMISTS.

POOLE: CHEMICAL ENGINEERS. CHEMISTS with experience in rubber technology.

ROSYTH: MECHANICAL ENGINEER with experience in welding development. ELECTRONIC PHYSICISTS.

Candidates must normally be natural born British subjects of natural born British parents, with First or Second-Class Hons. Degrees or equivalent qualifications. S.S.O.s must have had three years' post-graduate experience and be not less than 26 years of age. Salaries (men): S.S.O., £1233–£1460; S.O., £655–£1150 (London), somewhat lower in provinces.

Appointments unestablished (with F.S.S.U. benefits), but opportunities may occur for those under 32 to compete for established posts.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1 (quote A.483/9A). E7844

H.M. INSPECTOR OF FACTORIES

Pensionable career posts in Ministry of Labour for men and women, normally with Science or Arts Degree or comparable technical qualification, and preferably some industrial experience. Age at least 23 and under 30 on 1st June, 1960 (with extension for regular Forces service, Overseas Civil Service or exceptional qualifications). The duties are concerned with the safety, health and welfare of workers in industry.

Starting salary (London): £670–£772, according to age. Scale maximum £1065. Promotion prospects to £2000 and higher.

Write, Civil Service Commission, Burlington Gardens, London, W.1, quoting 280/11.

E8491

WILMOT BREEDEN FELLOWSHIP

Applications are invited for a Fellowship, to be held in association with the College of Advanced Technology, Birmingham. The value of the Fellowship, which is for a two-year term, is £1000 per annum.

A candidate for the Fellowship should normally have had two or three years' research or industrial experience. He should have an Honours Degree or equivalent qualification and be acceptable to the College of Advanced Technology as a research fellow.

The Wilmot Breeden Fellow would engage in an enterprise of such a character as to require the facilities both of the College and the Company, his time being spent at both. His enterprise may have the character of Scientific Research, Design, Development, a combination of some or all of these, or in some other way to be appropriate to the activities of Wilmot Breeden. The Company is especially concerned with Mechanisms, Electro-Chemistry, Metal Finishing, Metallurgy, Metal Formation, Hydraulics, Electronics.

Full details may be obtained on application to Mr. F. Sargeant, Secretary, Wilmot Breeden Fellowship Committee, Amington Road, Birmingham, 25.

Final applications must be received by the Secretary before 1st May 1960. E8473

TENDERS

METROPOLITAN WATER BOARD

TENDERS FOR THE SUPPLY OF STORES, &c.

TENDERS are invited for the SUPPLY of the following STORES and SERVICES for the period of 12 months commencing 1st April, 1960:

Contract No.	
1	Cement, tarmacadam, concrete slabs, earthenware bases, firebricks, fletton, stock and engineering bricks.
2	Brushes, brooms and handles.
3	Cast and spun iron straight pipes, cast iron specials.
4	Uniform clothing and caps, mechanics' overalls, rubber boots, shoes, &c.
5	Cotton waste, cleaning cloth, wipers, hemp, tarpaulins, &c.
6	Motor tyres, tubes, batteries, oils, &c.
8	Mild steel bars, plates, sheets, &c.
9	Black bolts and nuts, screws, files, shovels, &c.
10	Lead, pipe, solder, sheet, &c.
11	Fuel oil, kerosene, motor spirit.
12	Special lubricating oils.
13	Soaps, polishes and cleansers, oilman's sundries, paper towels and toilet rolls, &c.
14	Rubber and canvas insertion sheet and washers; suction, delivery, chemical and fire hose, &c.
19	Small iron castings, valve, hydrant and stopcock boxes, &c., non-ferrous castings.
20	Stopcocks, ferrule stopcocks, unions, disc fittings, hydrant outlets and caps.
21	Sluice valves, fire hydrants and parts, extension spindles, hydrant indicator plates, &c.
23	Periodical inspection, repair and maintenance of weighing apparatus.
24	Electric lamps and fluorescent tubes.
25	Steam, smithy and house coal, and coke.
26	Removal of furnace refuse.
27	Photo prints, &c.

Tenders must be submitted on the official forms, which may be obtained from the Chief Engineer by personal application at the offices of the Board (Room 171) or upon forwarding an addressed envelope (not smaller than 15in. by 10in.) and enclosing stamps value 1s. to cover postage, &c.

Applicants should refer to the number of the contract for which Tender forms are required.

Tenders, enclosed in sealed envelopes, addressed to the undersigned and endorsed in the manner indicated in the form of Tender, must be delivered at the offices of the Board (Room 122) not later than 12 noon on Thursday, 4th February, 1960.

The Board do not bind themselves to accept the lowest or any Tender.

S. D. ASKEW,
Clerk of the Board.

Offices of the Board,
New River Head,
Rosebery Avenue,
London, E.C.1. E8472

F.P.S. PART III

CALL FOR TENDERS

GREAT OUSE RIVER BOARD

FLOOD PROTECTION SCHEME

The Great Ouse River Board invite TENDERS for the THIRD PART of the FLOOD PROTECTION SCHEME.

The main works comprise:

(1) The Construction of the Cut-Off Channel of a length of approximately 27 miles, between Barton Mills and Denver. The quantity of excavation will amount to about 7,000,000 cubic yards.

(2) The construction of the Diversion Channels, Sluices and Syphons at the intersections of the Cut-Off Channel with the Rivers Wissey and Little Ouse and of the Head Sluice at the River Lark.

(3) The Construction of Road Bridges, Footbridges and Weirs, together with the Wissington Railway Bridge.

A copy of the drawings and other contract documents may be obtained on or after 18th January, 1960, from the Consulting Engineers, Sir M. MacDonald and Partners, 72, Victoria Street, London, S.W.1, on payment of a deposit of £20, which is returnable to bona fide Tenderers.

Application for the documents must be in writing.

Only Tenders from British and Commonwealth firms who have had experience in this class of work and who have or can obtain the necessary plant, will be considered.

Tenders must be received not later than mid-day on 18th March, 1960.

K. M. RODDIS,
Clerk of the
Great Ouse River Board.

Elmhurst,
Brooklands Avenue,
Cambridge. E8486

HAMPSHIRE COUNTY COUNCIL

BASINGSTOKE TECHNICAL COLLEGE

PHASE I

TENDERS are invited from suitable suppliers for the provision of Equipment detailed on the following schedules for the above new college. Suppliers interested may obtain the appropriate schedules direct from the Principal, Basingstoke Technical College, and completed Tenders are to be returned to the Clerk of the County Council, The Castle, Winchester, by 10th February, 1960.

Schedule II—Apparatus, Metrology.
Schedule I—Furniture, Drawing Offices.
Schedule III—Apparatus, Physics Laboratories.
Schedule IV—Apparatus, Chemistry Laboratories.
Schedule V—Apparatus, Biology Laboratory.
Schedule VI—Apparatus, Heat Engines Laboratory
Schedule VII—Apparatus, Testing Machines.
Schedule VIII—Apparatus, Electrical Machines and Equipment.
Schedule IX—Apparatus, Welding Workshops.
Schedule X—Apparatus, Woodworking Machinery
Schedule XI—Hand Tools, Engineering.
Schedule XII—Hand Tools, Building.
Schedule XIII—Teaching Aids, &c. E8501

EDUCATIONAL

CHESHIRE EDUCATION COMMITTEE

CHESHIRE COUNTY TRAINING COLLEGE, ALSAGER

ONE-YEAR COURSE OF TEACHER TRAINING FOR CRAFTSMEN

At the request of the Ministry of Education, the Cheshire Local Education Authority will provide, at the above-named College, from September, 1960, a new one-year course designed to give skilled Craftsmen teacher training to enable them to take up posts as teachers of Handicrafts in Secondary Schools.

Applications are therefore invited for admission to this course from men who already possess appropriate qualifications, such as a Full Technological Certificate of the City and Guilds of London Institute, or a Higher National Certificate or Higher National Diploma, and who wish to be trained as teachers.

The particular academic requirements of individual students and the application of their craft skills to the needs of schools will be specially studied. The year of training will include periods of teaching in schools.

The basic salary scale for qualified assistant teachers is £520 per annum, rising by annual increments of £27 10s., and one final increment of £40, to a maximum of £1000. Additional increments are given for approved qualifications and training. Account may also be taken of approved industrial experience acquired over the age of 21, up to a maximum of twelve increments.

Anyone needing further advice about the course, the qualifications required, the grants available to students while attending the course, and the teaching prospects available at the end of the course, should communicate with the Principal, the Cheshire County Training College, Alsager, Stoke-on-Trent. Applications for admission to the course should also be made to the Principal. Early application is advised.

JOHN G. KELLETT,
Director of Education.

County Hall,
Chester. E8538 E

COLLEGE OF AERONAUTICS

A SHORT COURSE ON

AIRCRAFT GAS TURBINE THEORY AND DESIGN

will be held at the College from Monday, 29th February to Friday, 18th March, 1960.

The course will deal mainly with performance, systems, turbo-machine aerodynamics and related design topics, but will include some experimental work on engines.

Fees for the course are £70 inclusive of full board and residence.

Further details and copies of the syllabus may be obtained on application to the Warden, The College of Aeronautics, Cranfield, Bletchley, Bucks. E8286 E

COVENTRY TECHNICAL COLLEGE

COURSE ON "METALLURGICAL FAILURES IN MECHANICAL PARTS"

A short COURSE intended for METALLURGISTS and ENGINEERS will be held on Thursday and Friday, 18th and 19th February, 1960. Course fee: 1 Guinea.

Particulars and application forms from Head of Chemistry Department. E8490 E

A.M.I.MECH.E., B.Sc., City and Guilds, etc Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent successes. 148-page prospectus free, on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A YOUNG MAN about 23 years of age is required to fill the vacancy of ASSISTANT TO TECHNICAL MANAGER of an expanding rubber company near London. It is intended that the successful applicant will eventually succeed the Technical Manager. The vacancy will interest men studying for G.I.M.E. The post requires a man capable of carrying out liaison work with customers and of carrying to fruition investigations relating to production problems. Commencing salary, £600 per annum, with participation in Staff bonus scheme. Reply in confidence.—BOX No. E8519, "The Engineer." A

AIR TREATMENT ENGINEER required for group of Mills near Manchester. Applicants should be capable of preparing schemes and estimates for new plants, and supervising erection and maintenance.

Please state experience, technical qualifications, age and salary required.—BOX No. E8522, "The Engineer." A

APPLICATIONS ARE INVITED from ambitious and resourceful men to fill the position of TECHNICAL ASSISTANT to the Sales Manager of Electric Lamp Machinery Manufacturers near London. A permanent, progressive and interesting job is offered to the right person, who must possess a sound engineering and commercial background in the trade.—Applications, with full particulars of education, experience and salary required, to BOX No. E171, "The Engineer." A

CHIEF ESTIMATOR required, with knowledge of Mechanical Handling Equipment and General Engineering. Attractive salary and conditions. Birmingham area.—BOX No. E8532, "The Engineer." A

SITUATIONS VACANT

CANADA

PLANT SUPERINTENDENT required for small steam Power Station in Canadian coastal area. Candidates should be well educated and have had several years' experience of electrical power generation. They will be expected to take complete charge of plant operation and maintenance. Salary will be around 7500 Canadian dollars per annum. Applications, giving full details of age, education, qualifications and experience to Messrs. Mackness & Shipley, Parliament Mansions, Abbey Orchard Street, London, S.W.1, quoting reference 2465.

E8479 A

CIVIL ENGINEERING ASSISTANTS

Applications are invited for the appointment of two CIVIL ENGINEERING ASSISTANTS with experience in the design and construction of works of sewerage and sewage disposal. Applicants should preferably hold an Engineering Degree or have passed Parts A and B of the Associate Membership Examination of the Institution of Civil Engineers.

The salary offered will be according to age, qualifications and experience of applicants, who should apply by letter, giving details and full particulars of experience and the names and addresses of two referees as to character and capabilities, to A. H. S. WATERS AND PARTNERS, CONSULTING CIVIL ENGINEERS, 25, TEMPLE ROW, BIRMINGHAM, 2.

E8502 A

CONSULTING ENGINEERS urgently require additional staff in London and Darlington, ENGINEERS and DRAUGHTSMEN for both reinforced concrete and steelwork.—Full particulars to F. R. Bullen and Partners, Dacre House, Dean Farrar Street, S.W.1. E8422 A

CONSULTING ENGINEERS, Westminster, require capable ASSISTANTS for varied reinforced concrete, steel and foundation work. 5-day week. Luncheon vouchers.—Write or 'phone, Maurice Nachshen and Partners, 58, Victoria Street, S.W.1. (Vic. 0285.) E8550 A

DESIGNER AND DESIGN DRAUGHTSMEN required for precision components used in the manufacture of internal combustion engines. Write, stating age, experience and present salary.—BOX No. E8517, "The Engineer." A

DESIGNER DRAUGHTSMAN

Aged 30/35, required by engineering firm in East Essex, to develop new ideas and to design rotating plant accordingly, to deal with problems of water treatment and purification.

Applicants must have had a workshop training in mechanical engineering, academic proficiency up to H.N.C. standard, and practical drawing-office experience in a responsible capacity.

Write, stating salary required and giving details of age, education and experience, to BOX No. E8545, "The Engineer." A

DEVELOPMENT ENGINEER

A Qualified MECHANICAL ENGINEER, aged 25–35, is required to take charge of the Development Section of the Engineering Department in London of a major international food manufacturing Company, and to be responsible for carrying out the Company's engineering research programme.

A thorough engineering background is essential with academic training up to Degree or H.N.C. level. Practical experience in design, operation or development in some of the following processes is required : food canning, wrapping and packaging—general food machinery—pharmaceutical and fine chemicals—and acid plant.

Initiative, ingenuity in design, and the ability to pursue a specified project from conception to final proofing are a fundamental requirement. This is a permanent appointment offering good prospects to a man with the ability and will to progress. Conditions of employment are excellent, and include a superannuation scheme. The salary will be assessed according to age, qualifications, and a record of proved ability.

Please write with full details of age, qualifications and experience.—BOX No. E8353, "The Engineer." A

DEVELOPMENT ENGINEER

A qualified Mechanical Engineer, aged about 40, is required by a firm in East Essex, to develop new ideas arising from market research, which will also form part of the appointment, into problems of water treatment and purification.

Practical experience in the design of rotating and static plant for such applications is essential, and the applicant should have had a sound academic training and a workshop apprenticeship in mechanical engineering.

Write, stating salary required and giving details of age, education, qualifications and experience, to BOX No. E8544, "The Engineer." A

DEVELOPMENT ENGINEER required for well-known Engineering Company expanding existing Foundry capacity. Applicants must have experience of machine design covering mass production of small castings, plant layout and be capable of seeing projects through from drawing-board to full production, educated to H.N.C. Write, stating full details of experience and salary required.—BOX No. E2677, "The Engineer." A

DRAUGHTSMAN

Applications are invited for the above post, which is located in Birmingham.

The work is interesting and varied and is mainly in connection with the design of industrial heating equipment. A knowledge of combustion technique and the use of rrefractories would, therefore, be an advantage.

Candidates should possess the Ordinary National Certificate in Mechanical Engineering as a minimum qualification.

The salary for the appointment, which is pensionable and subject to medical examination, will be within the range of £733–£853 per annum.

Applications, stating age, qualifications and experience, together with the names of two referees, should be addressed to the Industrial Relations Officer, West Midlands Gas Board, 6, Augustus Road, Edgbaston, Birmingham, 15.

E174 A

DRAUGHTSMEN required for interesting and varied work ; Sales promotion drawings and projects ; Layouts for steam raising and chemical plant. Also for Diesel Engine Installation. Should possess at least O.N.C. level with experience in general engineering.—Apply in writing, stating age, qualifications, experience and present salary level, to Labour Officer, BOX DR1703, A.K. Advg., 212a, Shaftesbury Avenue, London, W.C.2. E8489 A

DRAUGHTSMEN

There are several vacancies in the Design Office of the Central Engineering Establishment of the National Coal Board, Stanhope Bretby, Nr. Burton-on-Trent.

The work of this new establishment involves the design and development of many new kinds of equipment for the mining industry and is therefore, stimulating and of great interest.

Applicants should have a sound engineering background and possess H.N.C. or equivalent.

The vacancies occur in the following grades :—
Section Leader : up to £1400 per annum. (X.1612/2/F).
Senior Engineering Draughtsmen : up to £1065 per annum (X.1613/2/F).

There are attractive conditions of service, including superannuation. Applications, giving full details of age, qualifications and experience, should be sent to the Administrative Officer (quoting relevant number) at the above address, before 27th January, 1960.

E8524 A

ENGINEERING, PHYSICS AND SCIENCE GRADUATES OR EQUIVALENTS required for new appointments in the following fields :

(1) Fundamental and applied research on the dynamic behaviour of machine tools and problems associated with automatic control.

(2) Applied research and development of press working processes, cold extrusion and other new techniques for the forming of metals.

(3) Applied research on machining processes ; initially work will be concerned with the appraisal of new machining developments or studies of machining costs on a comprehensive scale.

(4) Research, design and development of a variety of mechanical engineering equipment including special machine tools, presses, mechanisms, test rigs, &c.

Successful candidates will be expected to take complete responsibility for projects from conception to completion. Capacity for creative thinking and initiative are important. The conditions of employment are attractive and there are excellent prospects for advancement. Superannuation scheme. Removal expenses paid.—Send full details in confidence to the Secretary, Production Engineering Research Association, Melton Mowbray, Leics. E8480 A

EXECUTIVE ENGINEER

Robinson and Sons, Ltd., of Chesterfield (Surgical Dressings Division), require a highly skilled and qualified Executive Engineer, aged 30 to 45, for the design and development of light specialised machinery for use in the manufacture of an extensive and varied range of products.

He will be responsible for the control and organisation of an existing staff in Chesterfield, including workshops for experimental and prototype construction and will be required to work closely with an engineering subsidiary in connection with the production of this specialised machinery. It is hoped that eventually he will become a Director of this subsidiary company. The first essentials are a capacity for invention and skill in light machinery construction but he should also be capable of advising on all general and maintenance engineering matters appertaining to a factory of 2000 employees. The position which presents exceptional prospects carries a commencing salary of not less than £1500, a pension and usual facilities.

Applications should be made to the Secretary, Robinson and Sons, Ltd., Wheat Bridge Mills, Chesterfield, and should be marked "Engineer" on the top left-hand corner of the envelope. E2678 A

LEADING PETROLEUM COMPANY have vacancies in the U.K. for qualified ENGINEERS. Candidates should have had thorough training in workshops and possess either Corporate Membership of the Institutions of Civil or Mechanical Engineers or have passed parts A and B of one of these Institutions' examinations or have qualifications entitling them to exemption from such examinations. Experience on pumps and pipelines or building construction would be advantageous. Excellent conditions of employment and starting salary appropriate to qualifications and experience. Apply, giving full details of age, qualifications and experience. (Replies can only be sent to those selected for interview).—BOX No. E8520, "The Engineer." A

JACKSON BROS. (OF KNOTTINGLEY), LTD.

require a DRAUGHTSMAN for work in modern, glass-producing factory on bottle-mould design. Experience in this class of work is desirable, but not essential. Canteen facilities.—Apply Personnel Officer, Jackson Bros. (of Knottingley), Ltd., Headlands Lane, Knottingley, Yorkshire.

E8484 A

MECHANICAL ENGINEERS : Due to expansion, a company specialising in centralised lubrication equipment require additional Engineers to work in the company's London Office (Edmonton, N.18), or as Sheffield and Scottish area Engineers respectively. Previous practical or sales experience of steelworks, heavy industry or lubrication an advantage.—Applications, stating age, qualifications, experience, &c., will be treated in the strictest confidence, to be addressed to : Managing Director, Centralube, Ltd., Park Royal Road, London, N.W.10. ELGar 3751. E8445 A

MECHANICAL ENGINEERING DRAUGHTSMAN, preferably holding H.N.C. or equivalent, experienced in textile dyeing and finishing machinery.—Applications, stating age, experience, qualifications and salary required to The Chief Engineer, The Bradford Dyers' Association, Ltd., 39, Well Street, Bradford, 1. E8459 A

MIDLAND FIRM REQUIRES A DESIGN ENGINEER in the field of gas compressors. Good academic qualifications are essential to cope with the wide range of engineering problems encountered, This post carries responsibility with excellent opportunities in a Company where personal contact is made with all departments at all levels.—BOX No. E8412, "The Engineer." A

PROJECT ENGINEER (aged 28–35 years) required by major contractors in the Petroleum and Chemical field for their London offices. The work involves broad direction of projects through the engineering and draughting phases, maintenance of close liaison with customers' engineers and general co-ordination of material procurement activities. Minimum qualification is A.M.I.Mech.E. Preference for man with B.Sc. (Eng.), or A.M.I.Chem.E.—Write fully, stating age, qualifications and experience, to : Staff Manager, Foster-Wheeler Limited, 3, Ixworth Place, London, S.W.3. E8533 A

QUALIFIED ENGINEER required for investigating vibration problems and assisting with the application of research results in industry. Applicant must be willing to travel and enjoy discussing problems with personnel at all levels of industry. Travelling expenses will be paid. Attractive salary and superannuation through F.S.S.U.—Full details to the Secretary (R.628), Production Engineering Research Association, Melton Mowbray, Leics. E8521 A

QUALIFIED MECHANICAL ENGINEER required to control production and maintain steam generation plant and chipboard machinery in new factory erecting in Australia. Previous timber experience desirable but not essential. Applicant must be willing to undergo Continental training before emigration within three months.—Write, stating age, previous experience and family circumstances, to Chipboard, 22, Bishopsgate, London, E.C.2, before interview London 20/22 January. E8530 A

SALES ENGINEERS required by Compressor Manufacturers for expansion of Sales Dept. Candidates should be qualified Mechanical Engineers holding H.N.C. or equivalent with sound practical knowledge and preferably sales experience in allied field. First class prospects for the right men. Full particulars including education, engineering training and qualifications, previous experience, age and salary required to The Managing Director, Reavell & Co., Ltd., Ranelagh Works, Ipswich. E2675 A

SENIOR DESIGN DRAUGHTSMEN, familiar with small mechanisms, etc., required by progressive and expanding Company situated approximately 20 minutes from Waterloo. The positions offered are permanent and provide excellent prospects for versatile men who seek interesting work in a new field.—BOX No. E169, "The Engineer." A

SENIOR PROJECT DRAUGHTSMAN required for Mechanical Handling Plants. Applicants must be able to lay out schemes. Experience in Estimating an advantage but not essential. Good prospects.—W. W. Brown & Partners, Ltd., 72, Newman Street, London, W.1. E2660 A

SPECIAL PURPOSE DESIGN DRAUGHTSMAN

required for Engineering unit situated in North West London area. Applicants should be over 28 years of age and will be required to show evidence of extensive practical experience coupled with a capability of developing new production techniques, including automatic handling. It is desirable that successful applicants should have reached a H.N.C. standard of education.

Applications will be treated in strict confidence and should be made in writing to.—BOX No. E8528, "The Engineer." A

TECHNICAL SALES ENGINEER required for leading manufacturer of components used in internal combustion engines, steam engines, air compressors, both for land and marine purposes. Applicant should have had sound engineering training and an aptitude for Sales Representation. Write, stating age, qualifications and experience and salary expected. —BOX No. E8487, "The Engineer." A

TWO (SENIOR) CRANE DRAUGHTSMEN with experience in design of Steelworks Cranes required. Only men with first-class background and experience should apply. Excellent working conditions. Salary will depend on age and experience.—Replies, giving age, full details of qualifications, experience and salary expected, should be addressed for the attention of the Chief Engineer, Guest Keen Iron and Steel Co., Ltd., East Moors, Cardiff. E8504 A

UNITED GLASS, LIMITED, RAVENHEAD WORKS, ST. HELENS

are about to engage two young ENGINEERS who will be given specialised training to fit them for supervisory positions in the Production Department. A good practical general engineering background is necessary and H.N.C. or equivalent in Mech. Eng. is desirable, but men otherwise suitable who have the O.N.C. and are studying for the higher certificate will be considered. Salary will be commensurate with qualifications and experience, and the positions are covered by the Company's Staff Pension Fund. For men with initiative and leadership qualities who are prepared to work on shifts, these vacancies will provide interesting work and prospects.

Applications, giving all relevant information, should be addressed to the Personnel Officer.

E8423 A

WANTED, FIRST-CLASS SENIOR DESIGN DRAUGHTSMAN for firm of General Engineers in Bristol. Good knowledge of general engineering, with particular reference to pressure vessels and stainless steel fabrication. This will be a well-paid position for the top-class man.—BOX No. E164, "The Engineer." A

WORKS ENGINEER, to control maintenance and general works services in Engineering Works in Home Counties. Preferred age 30 to 50, background to include apprenticeship and subsequent experience as mechanical and/or electrical engineer, with appropriate technical qualifications. For an enthusiastic cost-conscious engineer of broad vision, seeking an opportunity to lead an established department, the post is open at not less than £1500 p.a., with attractive conditions. Write, in confidence, giving fullest details of training and career.—BOX No. E8548, "The Engineer." A

WORKS ENGINEER required by International Manufacturers of surgical dressings, for their North Wales factory. Duties will include maintenance, installation and development of light mechanical machinery. Age 23/30. Good Engineering Degree essential. Salary £850–£1000 per annum. Pension scheme. Excellent working conditions. Apply, giving fullest details.—BOX No. E8495, "The Engineer." A

WORKSHOP MANAGER required in Kuwait, Persian Gulf. Applicants should have sound engineering background and be capable of taking charge of workshop specialising in repair and overhaul of petrol and diesel engines up to, say, 350 B.H.P. Free air passages, furnished accommodation, light and water.—Write, Personnel Officer, Mitchell Cotts Group, Ltd., Cotts House, Camomile Street, London, E.C.3. E8499 A

PUBLICITY ASSISTANT

required to handle engineering house journal and publicity matter. Good English essential. This is a senior position and candidates should have sound experience of technical publicity activities and some engineering background. Staff Pension and Life Assurance Scheme. Apply, giving full statement of personal details and experience (quoting ref. No. 801/C), to the

PERSONNEL MANAGER,
W. H. ALLEN SONS & CO., LTD.,
QUEENS ENGINEERING WORKS,
BEDFORD.

E8547 A

BICC

require a

GRADUATE PHYSICIST

or

MECHANICAL ENGINEER

for the Pilot Plant at their factory at LEIGH, LANCS. The work concerns the development of new electric cables and processes and provides good opportunities for inventiveness and originality. Previous industrial experience not essential, but those with a practical approach to problems are desirable. Salary according to age and experience. Staff superannuation scheme in operation. Written applications, stating age, experience and qualifications, should be addressed to :

Personnel Officer,
BRITISH INSULATED CALLENDER'S CABLES, LTD.,
Anchor Works, LEIGH, Lancs.

E8526 A

Classified Advts. continued on page 112

SITUATIONS VACANT

THE RICHARDSONS WESTGARTH GROUP

PROJECT ENGINEER

Applications are invited for an appointment as a PROJECT ENGINEER for the preparation of thermal-power generation and supply schemes. The work will require the ability to assess customers' requirements and to evaluate the economics of alternative schemes from basic data and to draw up the final specifications.

A broad knowledge of power generation practice is necessary together with appropriate experience with either a Consulting Engineer or in Industry.

This is a new appointment of senior status and offers considerable opportunity for development to a qualified and experienced engineer who wishes to work on his own initiative and responsibility. The ultimate prospects depend upon the success achieved by the selected applicant in an expanding field of activity.

There are Pension and Life Assurance Schemes in operation.

Apply, in strict confidence, to the Group Personnel Officer, Richardsons Westgarth & Co., Ltd., P.O. Box No. 2 Wallsend, Northumberland, quoting reference number H.-67D. E8525 A

SITUATIONS VACANT

APPLICATIONS INVITED FOR THE POSITION OF

PERSONAL ASSISTANT TO THE GENERAL MANAGER

CONTROLS DIVISION, HOPKINSONS LIMITED, HUDDERSFIELD.

Applicants to be within the 30/40 year age group, preferably with an Engineering Degree, administrative ability, and a practical knowledge of the light electrical engineering field.

Applications to be addressed to the General Manager.

E8426 A

SITUATIONS VACANT

PRODUCTION AND MAINTENANCE ENGINEERS

are required by the

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

(Production Group)

AT SPRINGFIELDS WORKS, SALWICK, PRESTON, LANCASHIRE

(A) PRODUCTION ENGINEERS to take charge of production shops manufacturing fuel elements for nuclear reactors. Three main processes are involved :

(*a*) Vacuum casting of uranium billets into rods.
(*b*) Heat treatment and machining of rods.
(*c*) Assembly of rods and other components into the finished fuel element.

Some of the production lines are new and include special purpose equipment and there is scope for men with initiative and adaptability who can tackle and solve technical and managerial problems. (Ref. SF.15/J1)

A good engineering background, experience of organising production and the ability to work closely with specialist service departments, are essential. A knowledge of metallurgy would be an advantage.

(B) PLANT MAINTENANCE ENGINEERS to be responsible to the Maintenance Engineer for the maintenance and commissioning of industrial type chemical plant, or machine shops engaged in the manufacture, on a production scale, of medium-sized machined components associated with fuel elements for nuclear reactors. (Ref. SF.16/J1)

Experience of chemical and machine shop plant is desirable.

FOR ALL POSTS a recognised engineering apprenticeship and corporate membership of a senior engineering institution, or equivalent, are essential. Possession of an honours degree in engineering may be an advantage. Managerial experience, together with ability to lead and direct labour, are essential.

Salary : £860 (at age 25 or over) to £1340 per annum, according to age, qualifications and experience.

Staff Housing Scheme. Contributory Superannuation.

Send postcard for application form, quoting appropriate reference, to Works Secretary at above address.

Closing date : 8th February, 1960.

E8531 A

SITUATIONS VACANT

PROJECT ENGINEER

Applications are invited for suitably qualified persons for appointment as Project Engineer in an expanding Division of an old-established Company in Yorkshire.

The work is concerned with controlled atmosphere generators and gas drying equipment, and the project engineer would be responsible for the design, installation and subsequent testing of new plant, and the work would involve some time spent on site.

Candidates should have a technical qualification in Chemical or Mechanical Engineering or Fuel Technology, preferably to degree standard.

Superannuation scheme and other benefits.

Salary by arrangement.

Please send brief details in confidence to Manager, Gas Handling Division, W. C. Holmes & Co., Ltd., Turnbridge, Huddersfield. E8436 A

DOWTY HYDRAULIC UNITS, LIMITED,

Ashchurch, Glos. (Industrial Division)

require a

PUMP DESIGNER

for the design of gear and piston pumps.

A minimum qualification of H.N.C. with wide experience in the field of industrial hydraulics is essential.

The successful candidate will enjoy excellent working conditions in an expanding organisation, including facilities for the extensive development of original thought.

A lodging allowance, assistance with removal expenses, and a contributory pension and life assurance are among the fringe benefits attached to this appointment.

Apply confidentially to the Personnel Manager.

E8537 A

METROPOLITAN WATER BOARD

have vacancies for

ASSISTANT ENGINEERS (Civil)
Salary scale : £980–£1210 per annum.
Applicants must be Corporate Members of the Institution of Civil Engineers and must have had sound engineering experience.

ENGINEERING ASSISTANTS (Civil and Electrical)
Salary scale : £700 (at age 21) to £945 per annum.
Applicants must have passed or be exempted from passing Parts I and II (or Sections A and B) of the examinations of the Institution of Civil Engineers or Electrical Engineers.

Permanent, pensionable posts.
Commencing salaries, according to age and experience.
Good opportunities for promotion.
Housing accommodation may be available at reasonable rental.
Offices hours 8.45 a.m. to 4.45 p.m. (Monday to Friday).
Staff restaurant, sports club, &c.
Forms of application from the undersigned, quoting reference (E).

S. D. ASKEW,
Clerk of the Board.

New River Head,
Rosebery Avenue, E.C.1. E8535 A

A SENIOR ENGINEERING APPOINTMENT

Owing to continued expansion, a leading Manufacturing Company requires a Senior Engineer to join their Head Office Staff in London.

Applicants, who should be 30–40 years of age, should be Graduates in Chemical or Mechanical Engineering, or hold a H.N.C. in these subjects. At least 10 years' experience in industry is required.

The Company's Engineering Department is responsible for designing and expediting facilities for a wide range of specialised non-mechanical products.

The appointment provides an outstanding opportunity for an experienced Engineer who wishes to obtain a position of responsibility. A salary of over £2000 p.a. is envisaged.

Please write, giving full details of career, to PERSONNEL MANAGER, BOX No. E8536, "The Engineer." A

OFFSITE CIVIL ENGINEER

Graduate Civil Engineer required to work as a member of a design team on refinery and petrochemical plant facilities. He should be a Corporate Member of the Institution of Civil Engineers and should preferably have had 3–5 years' experience with a contractor on design and estimating work on lump sum contracts plus some construction site experience. The work, which is varied, includes harbour and jetty, water intake and outfall design, marshalling yard and road layout work, grading calculations, etc. Knowledge of electronic computer calculation technique would be an advantage.

An above-average salary is offered for this position, according to age and experience. Comprehensive personnel benefits include pension scheme, overtime payment, excellent working conditions, Social Club, etc.

Please write to Personnel Manager,

KELLOGG INTERNATIONAL CORPORATION
7–10, CHANDOS STREET, CAVENDISH SQUARE, LONDON, W.1

Quoting Reference: G/153.

E8514 A

ENGLISH ELECTRIC RUGBY

require

ENGINEERS FOR DESIGN & DEVELOPMENT WORK

ON

STEAM TURBINES

Engineers holding a good honours degree or a further degree with, or without, previous turbine experience are invited to discuss at a preliminary interview attractive openings which are now arising in the Steam Turbine Division at Rugby. A few vacancies also exist for men with H.N.C. (Mech.) and several years' D.O. and Design Office experience on Steam Turbine and associated plant.

If you are interested you are invited to meet the Company's representatives for an informal discussion at any time between 6 and 7.30 p.m. on the following dates at the venues given:

WEDNESDAY, 20TH JANUARY	English Electric Branch Office, 200, St. Vincent Street, GLASGOW.
WEDNESDAY, 27TH JANUARY	English Electric Branch Office, Marconi House, Melbourne Street, NEWCASTLE.
WEDNESDAY, 3RD FEBRUARY	English Electric Co., Ltd., Marconi House, 336-7, Strand, LONDON, W.C.2.

However, if unable to attend for interview you are invited to write giving full details of your qualifications and experience to Dept. C.P.S., Marconi House, 336-7, Strand, London, W.C.2, quoting reference E 1150A.

E8518 A

SITE ENGINEER

A Site Engineer is required by F. H. Lloyd and Company Limited to take charge of the erection and installation of a steel foundry for the Indian Railway Board at Chittaranjan, West Bengal, India, for which F. H. Lloyd and Company Limited are acting as consultants.

Candidates should have similar experience on a major construction site preferably overseas, and have a high degree of technical competence and executive ability. A professional engineering qualification would be an advantage.

Before leaving for India the selected applicant will be required to work initially at F. H. Lloyd and Company Limited, Wednesbury, and thereafter to India for a period of up to 5 years. The post is advertised as a permanent career with F. H. Lloyd and Company Limited if the applicant so wishes.

Salary will be equivalent to £3000 per annum, tax free in India. Accommodation in India will be provided and generous leave facilities will be arranged.

The appointment is subject to the applicant satisfying the conditions imposed by the Indian Railway Board.

Apply, giving full details, to Chief Engineer, F. H. Lloyd and Company Limited, G.P.O. Box 5, Wednesbury, Staffs, not later than January 31, 1960.

E8553 A

SITUATIONS VACANT

CHIEF DRAUGHTSMAN

(Mechanical Handling)

A progressive Company in the North of England has a vacancy for a Chief Draughtsman. He must be thoroughly experienced in bulk materials handling and in package handling equipment (other than fork trucks), also in steel structures for supporting the equipment.

Applicants to state full details of their qualifications, positions held and range of experience. Age and availability to be given.

Qualities looked for include initiative, enthusiasm and drive.

A pension scheme and canteen are available and the position carries three weeks' holiday in addition to the statutory holidays.

A good salary and good prospects await the right man.—BOX No. E8507, "The Engineer."

A

SITUATIONS VACANT

LARGE MODERN STEEL FOUNDRY IN YORKSHIRE

requires a

CHIEF ENGINEER

to be responsible for all maintenance duties and for a large development programme. Wide knowledge of heavy engineering, together with civil engineering experience, is desirable. This is a senior executive position and will be remunerated as such.

A non-contributory pension scheme is in operation and assistance towards housing will be provided if necessary.

Replies, giving details of education and experience, together with an indication of salary required.—BOX No. E8498, "The Engineer."

A

SITUATIONS VACANT

A well established and expanding Company in the North East invites applications from Engineers for the following posts :

(a) CHIEF DESIGN ENGINEER
(b) CHIEF ESTIMATING ENGINEER
(c) PURCHASING ENGINEER

For each appointment, the main requirements will be an appropriate engineering qualification and experience principally in coded vessel fabrication, heat exchangers, tubular structures and pipeline work. The chosen applicants will control, in their respective fields, sections in the categories named and in several subsidiary lines of engineering activity.

The appointments will be top level carrying salaries commensurate with their responsibilities and superannuated ; the chosen applicants will be men with ideas and initiative, the ability to control staffs and the ambition to make progress. The preferred age range is 35 to 45.

Applications in confidence, giving fullest details, to BOX No. E2679, "The Engineer."

A

ENGINEER OR TECHNICAL ASSISTANT

required by

THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON, BERKSHIRE.

To assist a professional engineer engaged on design and engineering development from drawing-office to production stage of a wide variety of electronic, electrical and electro-mechanical instruments and equipments to meet scientists' requirements.

The selected candidate will gain experience in the latest constructional techniques such as printed circuits and potting of components.

Applicants should be Grad.I.E.E., or have equivalent qualifications.

If under 25 years of age, the successful candidate will normally be graded as Technical Assistant. Applicants over 30 will be expected to be qualified for appointment as Engineer. Those between 25 and 30 will be assessed according to qualifications and experience (salary scales for both grades are the same from 25 to 30).

A knowledge of one of the following is desirable : High Voltage Techniques up to 100 kV., Printed Circuits, Potting Techniques, Millimicrosecond circuits.

SALARY : £585 (at age 20)—£845 (at age 25)—£1315.

A Contributory Superannuation Scheme. A house, or substantial assistance with house purchase will become available for married officers living beyond daily travelling distance.

POSTCARDS for application forms to the Senior Recruitment Officer at above address. Please quote ref. 2495/25.

E8475 A

POWER RECTIFIER DESIGN

Due to expanding business, a large electrical manufacturing firm in the Midlands requires ASSISTANT DESIGN ENGINEERS for rectifier work. Previous rectifier experience not necessary but applicants should have degree (electrical) or equivalent, and some practical training. Work involves mercury arc and semiconductor rectifiers and application engineering of all kinds, with scope for wide experience and interest ; good salary and prospects. Pleasant residential area ; ample housing ; educational facilities excellent.

Apply with full particulars.—BOX No. E8509, "The Engineer."

A

BRITISH *Enka* LIMITED

PRODUCERS OF MAN-MADE FIBRES

The Company has been established for over thirty years, with international associations in Man-Made Fibres and Cellulose Film production ; it is entering the Cellulose Film field by establishing a production unit at Aintree, Liverpool.

REQUIRED FOR WORK ON THE CELLULOSE FILM PROJECT

1. SENIOR PROJECT ENGINEER

Mechanical Engineering degree or equivalent qualifications ; experience in design of mechanical plant and services, co-ordination of established designs and equipment, from D.O. stage to erection and "starting up." Salary according to age and ability, but by most standards in the "high bracket," as the position is a senior one demanding imagination, ability to work with others and ensure constant progress.

2. ASSISTANT PROJECT ENGINEER

As an Assistant to the Project Engineer. Would suit a younger man with similar qualifications. Will be required to take over responsibilities during absence, or as required. Opportunity will be given for direct responsibility for certain parts of project, making it possible to demonstrate personal ability for future advancement.

3. ENGINEERING AND EQUIPMENT PROGRESS MAN

Initially to work in this particular project, but permanent position either in this capacity or in Engineering Department available. Suit a man with experience of progress work on a large project, incorporating mechanical and electrical equipment, services, &c.

These appointments are new ones for a new project and as such have excellent future prospects in several directions, including transfer to positions in Production Management, according to the aptitudes and desires of the successful applicants.

The Company has a Staff Pension Scheme, is prepared to assist with housing and, through its international associates, will provide specialist training in the new project, and other fields, in associated Companies abroad.

REPLIES should be addressed "For personal attention of the Technical Manager," **BRITISH ENKA LTD., AINTREE, LIVERPOOL.**

E8488 A

ENGLISH ELECTRIC

require a

TECHNICAL SALES ENGINEER

There is a vacancy in our London office for a Technical Sales Representative to handle customers enquiries concerning Steam and Gas Turbines.

Applicants, who should be less than 35 years of age, must possess an engineering degree, or qualifications leading to Corporate Membership of the Institution of Mechanical Engineers ; Membership of the Institute of Fuel would also be advantageous. Previous experience of Sales liaison, although not essential, is desirable.

Please write giving full details of qualifications and experience to Dept. C.P.S., Marconi House, 336/7, Strand, London, W.C.2, quoting reference E 597F.

E8474 A

Classified Advts. continued on page 114

SITUATIONS VACANT

NATIONAL INSTITUTE FOR RESEARCH IN NUCLEAR SCIENCE

Project NIMROD

(7 GeV Proton Synchrotron)

CHIEF OPERATING ENGINEER

(Assistant Chief Engineer Salary £2400-£2900)

"NIMROD" the large Proton Synchrotron being constructed by the U.K.A.E.A. for the N.I.R.N.S. will be used for high energy nuclear physics research by research teams from Universities, the U.K.A.E.A. and other research institutions. To ensure full realisation of its potential, with economy of operating time, advance planning of machine operating programmes will be required. The Chief Operating Engineer will collaborate with Scientific teams in planning major experiments and will be responsible for ensuring that operating conditions are specified in advance.

He will be assisted by a staff of professional engineers and technicians and will be responsible to the Project Engineer.

Applicants should have a natural interest in experimental engineering/physics, have a Honours Degree in Physics or Engineering and should preferably have participated in large scale research and development work.

Housing and Superannuation Schemes.

Please send POST CARD to the Group Recruitment Officer (1549/25), U.K.A.E.A., A.E.R.E., Harwell, Berks.

E8476 A

SITUATIONS VACANT

ICI

Experienced Graduate Engineers

are required by

the manufacturers of the widest range of plastics, raw materials and semi-finished products in the Commonwealth.

THE PLASTICS DIVISION OF IMPERIAL CHEMICAL INDUSTRIES LIMITED is now expanding its Engineering Department in order to keep pace with growing sales in home and overseas markets. Enquiries are invited from :

MECHANICAL AND CHEMICAL ENGINEERS

holding first or second class honours degrees with some years of industrial experience.

The Division is looking for men of energy, initiative and proved ability. Good starting salaries will be paid immediately, and prospects for the future are excellent. The individual projects upon which candidates will be engaged vary in character and involve all types of engineering, from light precision machine work to heavy process. They include all the planning, layout and procurement associated with the design and erection of large manufacturing units. Some of the work is experimental, directed towards manufacture in new fields.

Conditions of service are good, and pension and profit-sharing schemes are in operation. For married men, temporary lodging allowances are available and assistance is given towards house purchase and removal expenses.

Apply briefly to :

The Staff Manager,
IMPERIAL CHEMICAL INDUSTRIES LIMITED,
Plastics Division,
Black Fan Road, Welwyn Garden City, Herts.

E8350 A

MECHANICAL ENGINEERS

IMPERIAL CHEMICAL INDUSTRIES LIMITED
GENERAL CHEMICALS DIVISION

has several vacancies for Mechanical Engineers wishing to make a career in the heavy chemical industry. The work is basically concerned with the maintenance and improvement of chemical plants, and there are plentiful opportunities to broaden experience in plant design and project engineering, construction, and a number of other activities in the Division which are carried out by engineers. Candidates should have a good Honours Degree in Mechanical Engineering, preferably have completed a graduate apprenticeship and be in the age range 23–30 years.

The Division spends several million pounds each year on new plants and maintains fully integrated design and factory staffs for the design, construction and maintenance of its installations, including most aspects of mechanical, electrical, civil and instrument engineering. Conditions of service include excellent starting salaries, Pension Fund and Profit-Sharing Scheme. Married men will receive a reasonable refund of removal (including travel) expenses, and to assist them in house purchase, facilities are available in approved cases for substantial loans ; in addition, legal charges will be advanced.

Engineers seeking a career with broad interests and excellent opportunities for considerable advancement should write, quoting reference ME21, to :—

STAFF MANAGER, IMPERIAL CHEMICAL INDUSTRIES LIMITED, GENERAL CHEMICALS DIVISION, CUNARD BUILDING, LIVERPOOL 3.

E8534 A

ICI

draughtsmen

To meet an expanding programme of development,

IMPERIAL CHEMICAL INDUSTRIES LIMITED
PLASTICS DIVISION

urgently need more Draughtsmen. In particular, men are required experienced in work associated with process plant, *e.g.* piping, heating and ventilating, drying, powder conveying and packing. Mechanical draughtsmen are also needed since the programme includes development work in novel processes which are essentially mechanical in nature. There are vacancies too for men with instrument and electrical design experience.

Good starting salaries will be paid and pension and profit sharing schemes are in operation. For married men temporary lodging allowances are available and assistance is given towards house purchase and removal expenses.

Apply briefly to the Staff Manager:

IMPERIAL CHEMICAL INDUSTRIES LIMITED
PLASTICS DIVISION
BLACK FAN ROAD, WELWYN GARDEN CITY, HERTS.

E8297 A

SITUATIONS VACANT

APC

ATOMIC POWER CONSTRUCTIONS LIMITED

RESEARCH & DEVELOPMENT LABORATORIES

Invite applications for the following :

A. GRADUATE MECHANICAL ENGINEERS

To supervise and plan experiments on the testing of fuel element components for reactors. A knowledge of electrical engineering or physics would be an advantage. Previous experience in the atomic energy industry is desirable but not necessary.

B. EXPERIMENTAL ASSISTANTS

To work on heat transfer mechanical testing and development of reactor fuel elements. Candidates should have the necessary educational background to proceed to a degree or a Higher National Certificate. Facilities for further education will be provided in certain cases.

C. TAPE PUNCHER/ COMPUTER OPERATOR

Young Lady, mainly concerned with preparing data-tapes for electronic computers and desk computing. Experience is not essential but accuracy in figure work is expected. Applicants with G.C.E. "O" level in Maths., Physics and English preferred.

Please write, stating age, qualifications, experience, present position, salary and indicating position applied for to :

The Assistant Personnel Officer, Atomic Power Constructions Limited, Research & Development Laboratories, Cranford Lane, Heston, Middlesex. E8471 A

SITUATIONS VACANT

SENIOR

PIPING

DESIGNER

DRAUGHTSMEN

A few vacancies exist for Senior Piping Designers. Top positions are available with us in this field, but consideration will be given only to men who have considerable experience in piping design and layout of refinery and chemical plants, or in related industries. Our Piping Designer-Draughtsmen are of a high standard and we therefore can consider only men of equal calibre.

Our permanent staff benefit from above average salaries, liberal personnel benefits, pension scheme, excellent working conditions, overtime payment, Social Club, etc. If you are interested and qualify, you are invited to write to, or telephone,

Personnel Manager,

KELLOGG INTERNATIONAL CORPORATION

7-10, CHANDOS ST., CAVENDISH SQ., LONDON, W.1. Tel: MUSeum 4010

quoting reference G/150.

E8515 A

SITUATIONS VACANT

BRITISH *Enka* LIMITED

PRODUCERS OF MAN-MADE FIBRES require

ASSISTANT TO CHIEF ELECTRICAL ENGINEER

for modern well-equipped plant. Experience of installation, maintenance and operational work with continuous processes and of E.H.T. and M.V. systems necessary. Chemical experience an advantage. Ability to organise and handle labour essential. Minimum qualifications—Graduate I.E.E., preferably A.M.I.E.E.

Good Salary and prospects. Pension Scheme with facilities for transfer, assistance with housing.

Applications, in confidence, should state age, qualifications, experience, in sequence, and be addressed to Personnel Manager,

BRITISH ENKA LIMITED
AINTREE, LIVERPOOL

E8529 A

AUSTRALIANS AUSTRALIANS AUSTRALIANS

With an Engineering Degree and practical experience in engineering production and factory management are invited to apply for a position of MANAGING DIRECTOR of a well-established and profitable engineering manufacturing company with a modern factory in Sydney.

The company is a wholly-owned subsidiary of a powerful Group with headquarters in Britain and world-wide connections. Full responsibility for the operation of the Australian subsidiary is vested in the Managing Director who has a local Board of Directors. The appointment carries a high basic salary with additional bonus calculated on profits and the use of a Company car, superannuation, and other benefits.

This is a splendid opportunity for an Australian with the qualities of management, initiative, and leadership, the qualifications of an engineer, and the experience of factory production, to secure a remunerative and responsible position in his own country.—Applications to BOX No. E8513, "The Engineer."

A

MISCELLANEOUS

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Continue to offer 7½ per cent. on sums £20–£300 (withdrawal on demand) with extra ¼ per cent. on each £500 unit.

Details and Audited Balance Sheet from Investment Dept. ER,
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LONDON, W.C.2.

E178 I

100 PER CENT. DEFERRED, 95 PER CENT. IMMEDIATE MORTGAGE. 2nd Mortgages our speciality. Apply without obligation.—Cranbrook Mortgage Bureau, 49, Cranbrook Road, Ilford, Essex. E177 I

BUSINESS OPPORTUNITIES

REMPLOY SPONSORSHIP SCHEME.—Send for details which show an attractive proposition to manufacturers.—Write to the Managing Director, Remploy, Ltd., 25–28, Buckingham Gate, S.W.1, or telephone VICtoria 6621 (12 lines). E155 O

FOR HIRE

LATTICE STEEL ERECTION MASTS (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1. E103 K

600

FORK LIFT TRUCKS FOR HIRE

Modern Machines Only
Diesel & Battery/Electric
Capacities 2000 lb–18,000 lb.
Contact your nearest Depot :

GEORGE COHEN,

SONS & CO. LTD.
WOOD LANE, LONDON, W.12.
(Shepherds Bush 2070)
And at Stanningley (Nr. Leeds) . Kingsbury (Nr. Tamworth) . Manchester . Glasgow Swansea . Newcastle . Belfast . Sheffield Southampton . Bath

E200 K

MACHINERY Etc. WANTED

REQUIRED STEAM TURBINE ALTERNATOR with capacity 600kW to 750kW, suitable for steam of 150 lb. p.s.i., and 550 Fahrenheit at Boiler stop valve stop.—Offers giving full details of plant and price to Superintendent Supplies, Colonial Development Corporation, 33, Hill Street, W.1. E8429 P

ONE Good quality second-hand hydraulically-operated CYLINDRICAL GRINDING MACHINE to be of the travelling wheel head type, and to accommodate items with a maximum diameter of 30in. and 144in. between centres.—BOX No. E8482, "The Engineer." P

FOR SALE

FOR SALE BY TENDER

BUTTERS 10-TON ELECTRICALLY OPERATED DERRICK

The Ministry of Finance for Northern Ireland has for sale a Butters 10-ton DERRICK.

Jib 120ft., power supply 132 h.p., 6-cylinder McLaren diesel engine coupled to a Brush 85kVA. A.C. Generator complete with switchboard and electric starting. Mounted on sectional pontoon with overall size 78ft. by 74ft. by 4ft. 6in. deep (3 sections each 26ft. by 74ft.). Pontoon controlled by two Sykes pneumatic double-drum winches powered by a 2-stage Broomwade compressor with Gardiner diesel engine with electric starting (complete with charging apparatus). Also mounted on pontoon : 1 Store-room 14ft. by 7ft. 6in. ; 1 Workshop approximately same size ; 1 No. 1000-gallon Fuel Storage Tank.

The plant may be inspected at Messrs. Farrans' workshop site at Killyhevlin, near Enniskillen, by arrangement with the Ministry's Resident Engineer, West Bridge House, Enniskillen (Telephone No. 2915). Documents may be obtained at Room 103, Law Courts Building, Belfast, 1. Tenders will be received up to 3 p.m. on 1st February, 1960. E8503

FRED WATKINS (ENGINEERING) LTD.

Fielding 500-ton Vertical Downstroke Hydraulic Press, 42in. by 36in. platens, with pumps and motors.
Fielding 200-ton ditto, 3ft. stroke, with pumps and motors (5 available).
Fielding 100-ton ditto, 4ft. to 5ft. stroke, with pumps and motors.
Two 73ft. 4in. by 4ft. Brick Lined Kilns or Dryers, with Crofts reduction gears and motors.
Two 26ft. by 4ft. Rotary Cooler or Dryers, with reduction gear and motor.

FRED WATKINS (ENGINEERING), LTD., COLEFORD, GLOS. E151 G

PILE DRIVING EQUIPMENT.—New and second-hand. Following available for immediate sale at reduced prices. Raising and Rigid Pile Frames, Diesel and Steam Winches, Spencer-Hopwood Steam Boilers, Drop Hammers, Automatic Steam Hammers and Piling Helmets. Write for complete list.—BOX No. E8493, "The Engineer." G

Classified Advts. continued on page 116

WEATHERLEY OILGEAR LIMITED

TO SERVE THE MORE ADVANCED FIELD OF HYDRAULICS

REQUIRED: SENIOR TECHNICAL SALES ENGINEERS

to operate as district representatives for London and South—Midlands—Northern England—Scotland. Applications are invited from those already residing centrally in these areas.

Age Group : 35 to 45 years of age.

An informative period will be foreseen but qualifications should include a good practical as well as technical knowledge and experience of the modern version of Hydraulic and Processing Applications for industry at large.

Also required are four layout engineers, either experienced in Hydraulic Application or with good technical qualifications for training.

Applicants are asked to forward fullest information, including education, training and experience (present Salary Status will help) and sufficient detail to facilitate early arrangements for interview in London.

Address to : Personnel Manager, HYDRAULIC DIVISION, Weatherley Oilgear Limited, Biggleswade, Beds.

E8189 A

J. STONE & CO. (DEPTFORD) LTD.

ARKLOW ROAD, S.E.14.

This old-established Engineering Company of International repute is engaged on an expanding volume of work on new products and is therefore seeking suitable men to fill the following posts :

ENGINEER : For work involving steam technology. Preferably of B.Sc. Eng. standard—H.N.C. standard acceptable, if supported by relevant experience.

DESIGN & DEVELOPMENT DRAUGHTSMEN (SENIOR & JUNIOR): For mechanical and electrical work—should have served an apprenticeship and have minimum standard of O.N.C.

LABORATORY TECHNICIANS: For research and development work. Should have H.N.C. and have electrical/mechanical experience.

Salaries for the above posts will be commensurate with age and experience. The work is interesting and offers good prospects to the right men.

Applications, giving full details of age, education and experience to the Personnel Manager.

E8539 A

SUB-CONTRACTING

MOBILE LIFTING SERVICES.—Lump sum or Hire Rate Quoted for any Lifting Work by Lorry-Mounted or Crawler Cranes, any size, any area.—TARSLAG, LTD., Rotherham 3235. E167 MW

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone : Knottingley 2743/4). E116 MW

PATENTS

THE PROPRIETOR of British Patent No. 719939, entitled "MATERIAL SEPARATING APPARATUS," offers same for license or otherwise to ensure practical working in Great Britain.—Inquiries to Singer Stern & Carlberg, 14, E. Jackson Blvd., Chicago 4, Illinois, U.S.A. E8424 H

THE PROPRIETOR of British Patent No. 720,206, for "IMPROVEMENTS IN AND RELATING TO PIPE BENDS," desires to enter into negotiations with a firm or firms for the Sale of the Patent or for the Grant of Licences thereunder.—Further particulars may be obtained from Marks and Clerk, 57 and 58, Lincoln's Inn Fields, London, W.C.2. E8542 H

FOR SALE

600

ELECTRICALLY-DRIVEN COMPRESSOR SETS FOR USE ON 400/440 VOLTS, 3-PHASE, 50 CYCLES SUPPLY

1000 c.f.m. ALLEY & MACLELLAN, 100 p.s.i.
Two 750 c.f.m. ALLEY & MACLELLAN, 100 p.s.i.
Two 668/674 c.f.m. C.P.T., 100/125 p.s.i.
625 c.f.m. ALLEY & MACLELLAN, 100 p.s.i.
Two 600 c.f.m. BROOM & WADE, 100 p.s.i.
320 c.f.m. CLIMAX ENGINEERING, 100 p.s.i.
305 c.f.m. HOLMAN, 100 p.s.i.
246 c.f.m. INGERSOLL RAND, 100 p.s.i.
150 c.f.m. REAVELL, 100 p.s.i.
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Five 1925 c.f.m. BELLISS & MORCOM, 100 p.s.i., with 400 h.p. slipring motors, 3000/3/50 cycles supply, complete with control gear.

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SONS AND CO. LTD.
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Tel.: Shepherds Bush 2070; and STANNINGLEY, Nr. LEEDS.
Tel.: Pudsey 2241. E202 G

FOR SALE

ONE No. 320 Bastian and Allen Electrode STEAM BOILER rated at 150kW on a 400/440 volt, 3-phase, 50 cycle supply. Maximum working pressure 300 p.s.i., output 500 lbs. steam per hour from and at 212 deg. Fah. Complete with all necessary mountings, motor operated feed pump, wall mounting control panel and main oil circuit breaker, and 100 gallon M.S. feed and condense tank.

ONE "Autolec" BOILER. Makers, G.W.B. Electric Furnaces, Ltd., Dudley, Worcs. Rating: 70kW, 400/440 volts, 3-phase, 50 cycles, working pressure 120 p.s.i. Equipment No. 544C.

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E8497 G

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HYDRAULIC PUMPS

Hydraulic Accumulators, Valves, Fittings, New and Second-hand. Complete installations. All kinds of Hydraulic Equipment in Stock.

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East 1844/5. E111 G

CRANE—Second-hand bargain, Jones Super 22 Mobile Saloon Cab Full circle slew, Turner diesel engine, 13ft. 9in. cantilever jib, lift 2 ton at 8ft. radius. Inspection Dartford, Kent. Cash or terms. —Write Room 66, Empire House, Piccadilly, London. HYD 1789. E2674 G

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TWY

RAILS FOR SALE

100 TONS NEW SLIGHTLY DEFECTIVE B.H. RAILS. 95 lb. yard, chiefly 60ft.
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100 TONS SECOND-HAND BULL HEAD RAILS, 90/95 lb. yard, chiefly 44ft. 6in. lengths.
50 TONS NEW SLIGHTLY DEFECTIVE F.B. RAILS, 93-34 lb. yard, chiefly 41ft.
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250 TONS SECOND-HAND F.B. RAILS, about 60 lb. yard, 24ft., 27ft., 30ft. and 45ft.
10 TONS SECOND-HAND COACH SCREWS, 6¾in. by 1¼in., Standard Railway Pattern.
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WARD'S ALSO HAVE LARGE STOCKS OF ALL CLASSES OF OTHER RAILWAY MATERIALS.

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ALBION WORKS - - - SHEFFIELD
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E216 G

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FRORIEP 54IN. HEAVY DUTY VERTICAL TURNING AND BORING MILLS,

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E8478 G

"PELS" TYPE EFG 20 SECTION CROPPING MACHINE for sale. Steel plate frame. Crops rounds up to 2¾in., squares 2in., flats 5in. by 1¼in., or 6in. by ⅜in., angles and tees at right angles 6in. by 6in. by ½in., angles and tees on mitre 4in. by 4in. by ½in. Arranged motor drive 400/3/50. Weight about 50 cwt.—F. J. EDWARDS LIMITED, 359, Euston Road, London, N.W.1, or 41, Water Street, Birmingham, 3. E8552 G

FOR SALE

STEEL FRAMED BUILDINGS FOR SALE, 8ft. to 400ft. clear width, as Workshop, Storage, Hangar Buildings, &c.—Please write details of requirements; Bellman Hangars, Ltd., Hobart House, Grosvenor Place, London, S.W.1. E176 G

HAVE YOU A STOCKPILE HANDLING PROBLEM? A self-loading, self-discharging rotary disc loader is immediately available. Capacity between 70 tons per hour for coke and 200 tons per hour for ore. Electric drive from 400/440 volts, 3-phase, 50 cycle supply. Caterpillar tracks. Discharge conveyor slews through 180 degrees. One-man operated. For further information, telephone SIMONSWOOD 3361, or write, Lt.-Col. B. M. Butler, Search (Liverpool) Limited, Hammond Road, Kirkby Trading Estate, Liverpool. E8551 G

FOR SALE

WATER PUMPING PLANT

COMPRISING:

ONE Worthington-Simpson 3F3 Vertical "Freflo" Ball Bearing CENTRIFUGAL PUMP, 100 g.p.m., 62ft. head. 8 b.h.p. Crompton Parkinson motor, 400/440 volt, 3-phase, 50 cycles.

ONE Worthington-Simpson 2½ DM4 Monobloc PUMPING SET, 100 g.p.m., 66ft. head. 4 b.h.p. motor, 400/440 volt, 3-phase, 50 cycles.

ONE Auto-Klean "Flushflo" STRAINER, Automatic type, all non-ferrous internals, geared Reduction Motor, Motorised Flushing Valve, suitable for dealing with 100 g.p.m. of water on discharge side.

ONE 1000 gallon collecting TANK Farrer's manufacture, 8ft. by 5ft. by 4ft., ⅜in. thick Steel Plate.

TWO Worthington-Simpson 2 DM7 Monobloc PUMPING SETS, 100 g.p.m., 160ft. head. Two 10 b.h.p. Drip and Splash-proof Squirrel Cage Induction Motors, 400/440 volts, 3-phase, 50 cycles.

ONE COMPRESSION TANK, Farrer's manufacture, 5ft. 10in. diameter by 12ft. long, Manhole, Relief Valve, Water Level Gauge, Train Cock, Pressure Gauge and Air Cock, Working Pressure 90 p.s.i.

Apply to:
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E8496 G

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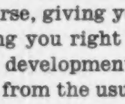
LEVER OR AIR OPERATED
ALL STEEL CONSTRUCTION



MAXIM CONVEYORS (ENGLAND) LTD., BELVEDERE, KENT
Ring ERITH 4223
E170 G

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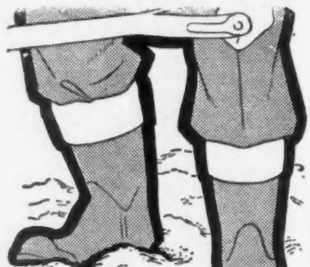
HIGH CLASS POWER PLANT FOR DISPOSAL comprising:—
2000kW Metropolitan-Vickers TURBO-ALTERNATOR SET, pass out Turbine 250 lbs. pressure, pass-out 30 lbs., coupled through reduction gearbox to Alternator, 440 volts, 3-phase, 50 cycles, 1000 r.p.m., condensing plant and control gear.
1000kW Metropolitan-Vickers TURBO-ALTERNATOR SET similar to above.
Battery of TWO Brick set ECONOMIC BOILERS by Daniel Adamson, 10ft. diameter by 15ft. 6in. long, with Hodgkinson Mechanical Stokers, Green's Economiser of 480 tubes, I.D. Fan, Superheaters and 3 Weir Pumps, Working pressure 265 lbs. per square inch; superheated 560/640 deg. Fah., total capacity 25,000 lbs. per hour.
BOX No. E8382, "The Engineer." G

NISSEN TYPE HUTS for sale. Prompt despatch of 16ft., 24ft., and 30ft. wide huts; also "Romney" Huts, 35ft. wide, and "Blister" Hangars, 86ft. 6in. and 91ft. wide. These buildings are in various lengths and comprise steel framework with galvanised corrugated steel sheeting.—Full details from Dept. 115, J. Thorn and Sons, Ltd., Brampton Road, Bexleyheath, Kent. (Tel.: Bexleyheath 305). E113 G



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SAW DOCTORS
WELDERS
in
THE ROYAL ENGINEERS
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Up to £25 tax-free Bonus plus first-rate wages for two weeks of your time

ARE you in a skilled trade? Then you can probably add a tidy sum to your income by joining the Army Emergency Reserve. For one thing, you get pay and allowances at full Regular Army rates whilst in camp. And the more your skill is worth in civilian life, the higher your Army trade pay will be. Better still, you also get £9-£25 bonus tax-free.

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POST THIS OFF RIGHT AWAY!

Please send me—without obligation—the illustrated booklet telling all about the Army Emergency Reserve.

NAME _____

ADDRESS _____

_____

TRADE _____ (JU/AER)

Enter No. 1161 on reply card

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FRED WATKINS (ENGINEERING) LTD.

STEAM BOILERS.—Cochrane Vertical (New), 8ft. 6in., 8ft., 7ft. 6in., 7ft. and 6ft. in dia., 100/150 lb. w.p.; reconditioned 8ft. 6in. down to 3ft. dia.; Economic 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p. 300 reconditioned Vertical Crosstube, all sizes.
AIR COMPRESSORS.—Two Bellias & Morcom 2500 c.f.m., 100 p.s.i., 550 h.p. motors; also Broomwade 500, 400, 300, 200 and 130 c.f.m., all motorised; and several others of various makes and capacities.
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	Universal rigid lap machine; single action power press; spot welders; annealing, cutting, trimming and tapering machines; saw bench; draw presses; gravity roller conveyor straights; tyres; tubes; petrol and water cans; seats and cushions; accumulators; towing ropes; hydraulic and screw jacks; fire extinguishers; tyre pumps and inflators; carburettors; generators and other M.T. spares; leather tool bags; auxiliary charging sets; storehouse trucks; hand stackers; fire pumps; folding tables; chairs; cupboards and cabinets; refrigerators; webbing; canvas canopies; Kraft, creped and waterproof paper; hessian wrappers; paper packed hessian; twine; rope; cordage; khaki drill skirts; motor cyclists' boots; rubber thigh boots; textiles; clothing; footwear, etc.		
February 10	**Miscellaneous stores.**	Technical Stores Depot, Old Dalby, Leics.	SHOULER & SON (Dept. L), 1, Norman Street, Melton Mowbray, Leics. (Tel.: 3081.)
February 18	**Miscellaneous stores.**	M.O.A. Storage Depot, Rotherwas, Hereford.	RUSSELL, BALDWIN & BRIGHT, LTD. (Dept. L), 20, King Street, Hereford. (Tel.: 4366.)
February 25	**Vehicles and miscellaneous stores.**	M.O.A. Storage Depot, Bowhouse, Hurlford, Nr. Kilmarnock, Ayrshire.	DIXON & WALLACE, LTD. (Dept. L), Bank Buildings, Graham Street, Glasgow, E.1. (Tel.: Bridgeton 2447/9.)

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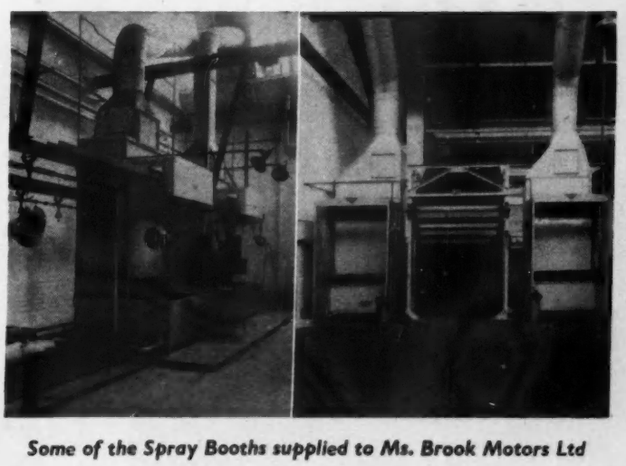

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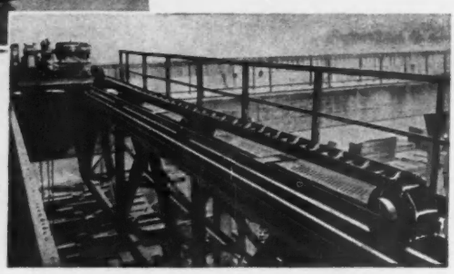

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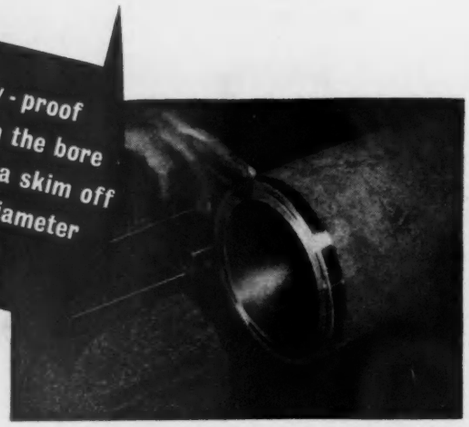

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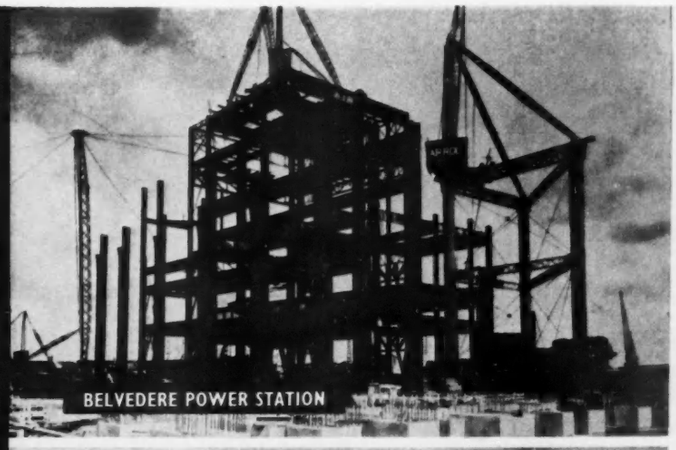

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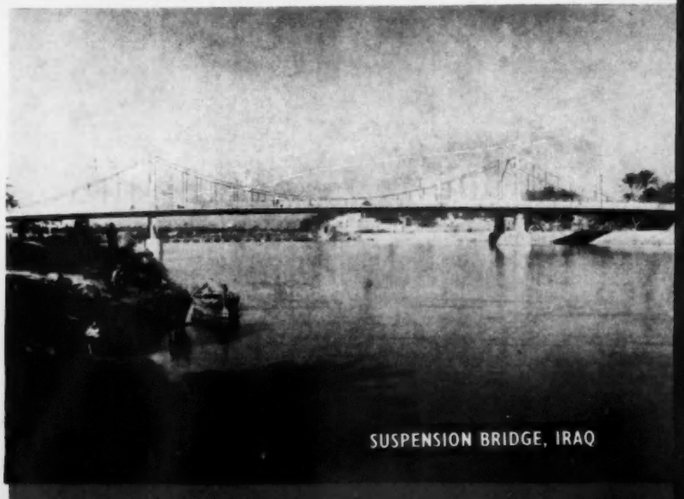

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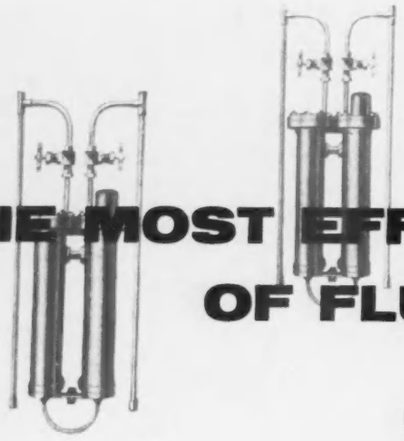

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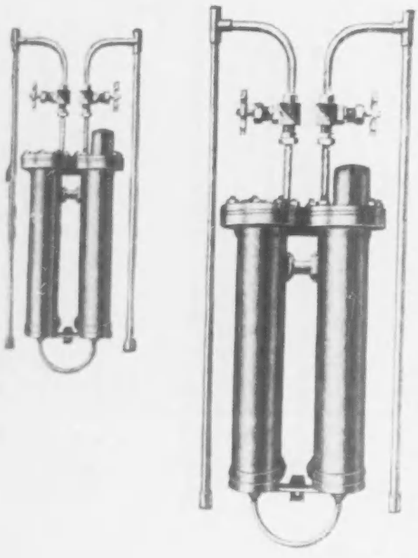

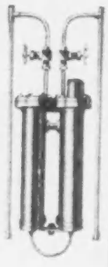

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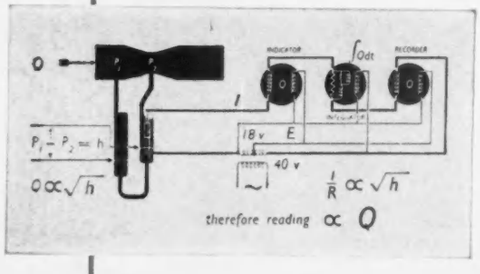

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6" x 6" rate-of-flow indicator

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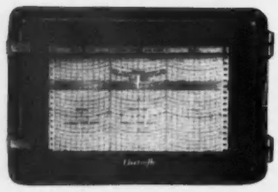
Model No. 355 12" diam. rate-of-flow indicator.



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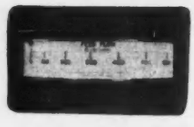

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